State of New York — Department of Agriculture.

Seventeenth Annual Report

OF THE

BOARD OF CONTROL

OF THE

NEW YORK

Agricultural Experiment Station

(GENEVA, ONTARIO COUNTY)

For the Year 1898,

WITH REPORTS OF DIRECTOR AND OTHER OFFICERS.

TRANSMITTED TO THE LEGISLATURE APRIL 28, 1899.

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1899.

STATE OF NEW YORK.

No. 77.

IN ASSEMBLY,

APRIL 28, 1899.

SEVENTEENTH ANNUAL REPORT

OF THE

Board of Control of the New York Agricultural Experiment Station.

STATE OF NEW YORK:

DEPARTMENT OF AGRICULTURE,

ALBANY, *April* 28, 1899.

To the Assembly of the State of New York:

I have the honor to herewith submit the Seventeenth Annual Report of the Director and Board of Managers of the New York Agricultural Experiment Station at Geneva, N. Y., in pursuance of the provisions of the Agricultural Law.

I am, respectfully yours,

CHARLES A. WIETING,

Commissioner of Agriculture.

1898.

ORGANIZATION OF THE STATION.

BOARD OF CONTROL.

GOVERNOR BLACK, Albany.
WILLIAM C. BARRY, Rochester, Monroe Co.
S. H. HAMMOND, Geneva, Ontario Co.
MARTIN V. B. IVES, Potsdam, St. Lawrence Co.
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NICHOLAS HALLOCK, Queens, Queens Co.
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G. HOWARD DAVISON, Millbrook, Dutchess Co.

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W. O'HANLON, *Secretary and Treasurer.*

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W. C. BARRY,
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F. C. SCHRAUB,
LYMAN P. HAVILAND,
G. HOWARD DAVISON.

STATION STAFF.

W. H. JORDAN, SC. D., *Director.*

GEO. W. CHURCHILL, *Agriculturist and Superintendent of Labor.*
WM. P. WHEELER, *First Assistant (Animal Industry).*
F. C. STEWART, M. S., *Botanist.*
L. L. VAN SLYKE, Ph. D., *Chemist.*
C. G. JENTER, Ph. C.,
*W. H. ANDREWS, B. S.,
J. A. LECLERC, B. S.,
*A. D. COOK, Ph. C.,
FRED D. FULLER, B. S.,
*E. B. HART, B. S.,
F. THOMPSON, B. S., *Assistant Chemists.*
GEO. A. SMITH, *Dairy Expert.*
FRANK H. HALL, B. S., *Editor and Librarian.*
VICTOR H. LOWE, M. S.,
†F. A. SIRRINE, M. S., *Entomologists.*
S. A. BEACH, M. S., *Horticulturist.*
WENDELL PADDOCK, B. S.,
C. P. CLOSE, M. S., *Assistant Horticulturists.*
FRANK E. NEWTON,
JENNIE TERWILLIGER, *Clerks and Stenographers.*
A. H. HORTON, *Computer.*

Address all correspondence, not to individual members of the staff, but to the NEW YORK AGRICULTURAL EXPERIMENT STATION, GENEVA, N. Y.

The Bulletins published by the Station will be sent free to any farmer applying for them.

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* Connected with Fertilizer Control.
† Connected with Second Judicial Department Branch Station.

TABLE OF CONTENTS.

Seventeenth Annual Report

OF THE

Board of Control of the New York State Agricultural Experiment Station.

TREASURER'S REPORT.

Geneva, N. Y., *October* 1, 1898.

To the Board of Control of the New York Agricultural Experiment Station:

As Treasurer of the Board of Control, I respectfully submit the following report for the fiscal year ending September 30, 1898:

Maintenance Account.

Receipts.

1897.			
Oct.	1.	To balance on hand	$678 41
		To amount received for produce sold..	2,221 18
		To amount received from Comptroller,	52,500 00
			$55,399 59

Expenditures.

By building and repairs	$6,729 85
By chemical supplies	746 57
By contingent expenses	550 52
By feeding stuffs	380 35

By fertilizers	$287 00
By freight and express	576 17
By furniture and fixtures	726 86
By heat, light and water	1,628 07
By labor	12,073 43
By library	1,337 53
By live stock	598 88
By postage and stationery	1,156 18
By publications	4,168 12
By salaries	19,069 58
By scientific apparatus	196 55
By seeds, plants and sundry supplies	2,484 49
By tools, implements and machinery	508 79
By traveling expenses	1,588 88
By balance	591 77
	$55,399 59

EXPENSE OF BULLETINS AND ENFORCING PROVISIONS OF CHAPTER 955, LAWS 1896.

Receipts.

To amount received from Comptroller, $12,500 00

Expenditures.

1897.		
Oct. 1.	By account overdrawn	$1,101 19
	By chemical supplies	98 43
	By contingent expenses	3 02
	By freight and express	36 55
	By heat, light and water	191 74
	By postage and stationery	1 83
	By publications	1,574 85
	By salaries	6,335 11

	By seeds, plants and sundry supplies..	$7 64
	By tools, implements and machinery..	75
	By traveling expenses..............	1,193 90
	By balance	1,954 99
		$12,500 00

POSTAGE ACCOUNT, SPECIAL APPROPRIATION.

1897.		
Oct. 1.	To balance on hand	$282 00

Expenditures.

18.	By postage	$282 00

REPAIRS TO BUILDINGS, SPECIAL APPROPRIATION.

1897.		
Oct. 1.	To balance on hand...............	$1 54

Expenditures.

	By repairs to buildings	$1 54

SECOND JUDICIAL DEPARTMENT, CHAPTER 675, LAWS 1894.

Receipts.

1897.		
Oct. 1.	To balance on hand	$46 34
	To amount received from Comptroller,	6,142 12
		$6,188 46

Expenditures.

	By chemical supplies	$50 15
	By contingent expenses	14 58

By rents (land)	$1,222 00
By fertilizers	161 63
By freight and express	34 95
By furniture and fixtures	1 50
By heat, light and water	29 99
By labor	321 95
By postage and stationery	38 07
By salaries	3,168 96
By scientific apparatus	6 86
By seeds, plants and sundry supplies	358 37
By tools, implements and machinery	123 31
By traveling expenses	609 80
By balance	46 34
	$6,188 46

SPECIAL APPROPRIATION FOR BIOLOGICAL AND DAIRY BUILDING, CHAPTER 315, LAWS 1897.

Receipts.

To amount received from Comptroller,	$31,865 09

Expenditures.

By construction	$26,488 71
By equipment	5,376 38
	$31,865 09

All expenditures are supported by vouchers, approved by the auditing committee of the Board of Control, and have been furnished the Comptroller of the State of New York.

UNITED STATES APPROPRIATION UNDER ACT OF CONGRESS APPROVED MARCH 2, 1887.

To receipts from the Treasurer of United States as per appropriation for fiscal year ending June 30, 1898, as per act of Congress, approved March 2, 1887	$1,500 00

Expenditures.

By chemical supplies	$49 89
By feeding stuffs	20 00
By labor	1,147 61
By live stock	220 00
By salaries	62 50
	$1,500 00

WILLIAM O'HANLON,
Treasurer.

DIRECTOR'S REPORT.*

To the Honorable Board of Control of the New York Agricultural Experiment Station:

Gentlemen.— I have the honor to present herewith the report of the New York Agricultural Experiment Station for 1898.

The past year has been characterized especially by the completion of plans which for some time you have had under consideration and development.

Notable additions have been made to the building and apparatus equipment; the scientific staff has been enlarged, and the scope and efficiency of the Station facilities for studying problems important to agricultural practice have been much increased thereby.

It is very gratifying to be able to report, also, that all this has been accomplished, at the same time that the usual activities of the Station have been fully maintained, with the most harmonious thought and action on the part of all concerned. Neither internally nor externally has the work of the Station suffered from dissensions or unpleasant criticism, a condition of things for which your director desires to make profound acknowledgment.

THE STATION STAFF.

In my report for 1897, mention was made of the election of Mr. H. A. Harding as Dairy Bacteriologist and Mr. G. A. Smith as Dairy Expert. Both of these gentlemen now have entered upon their duties, their work being located in the dairy section of the new building. Mr. Harding spent about six months of the year in very useful observation and study at the laboratories of

* Reprint of Bulletin No. 153.

PLATE I.—BIOLOGICAL AND DAIRY BUILDING.

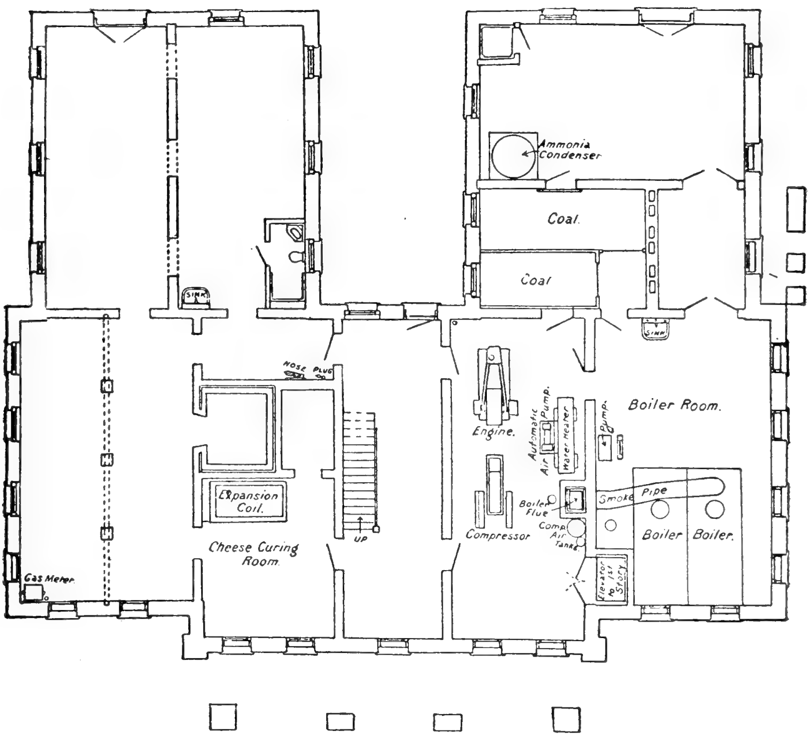


FIG. 1.—BASEMENT PLAN OF BIOLOGICAL AND DAIRY BUILDING.

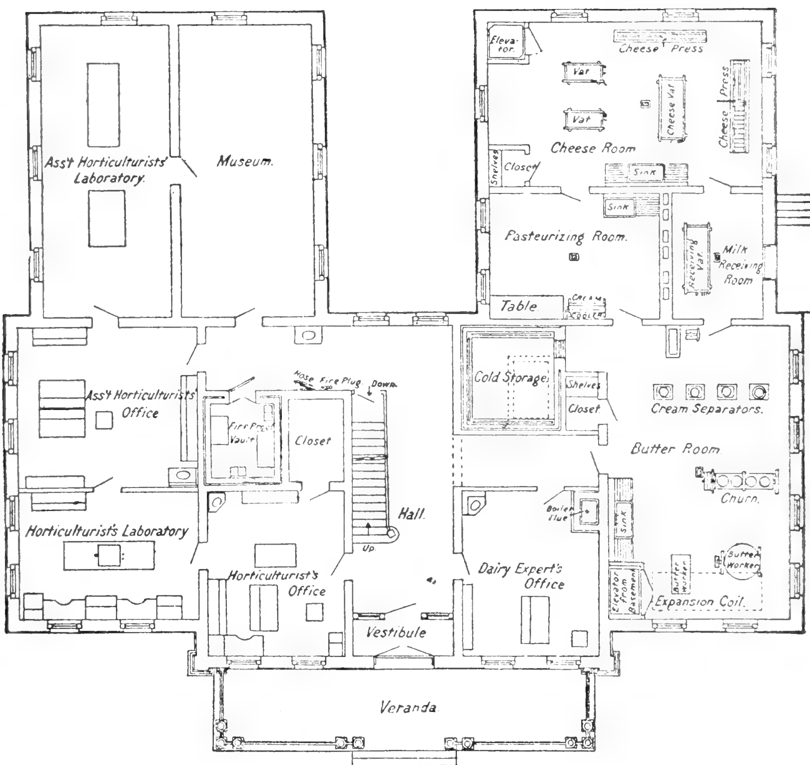


FIG. 2.—FIRST FLOOR PLAN OF BIOLOGICAL AND DAIRY BUILDING.

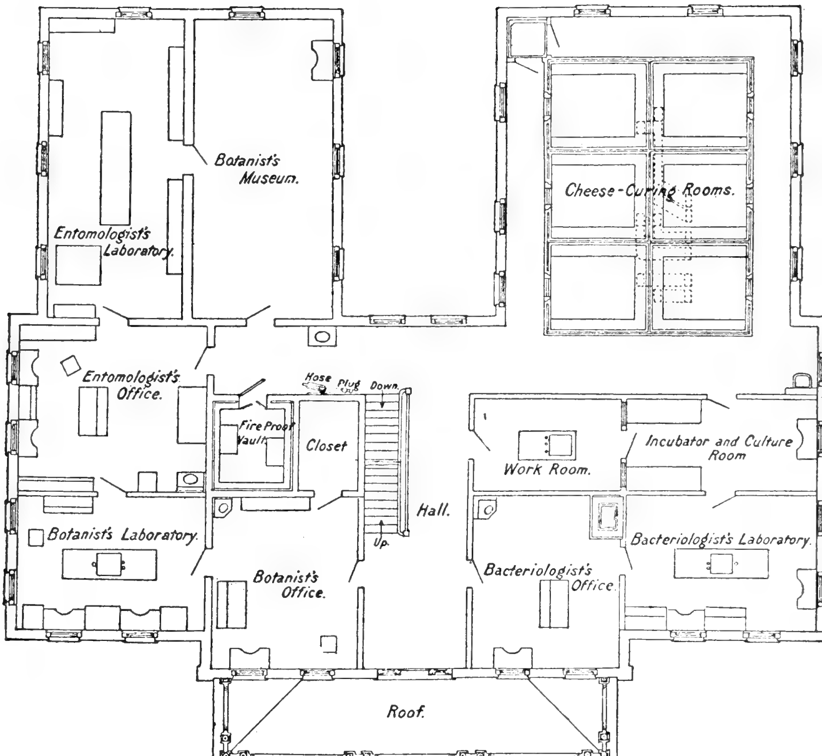


FIG. 3.—SECOND FLOOR PLAN OF BIOLOGICAL AND DAIRY BUILDING.

Europe, in order to become familiar with current subjects and methods of European research.

At the time of my last report, the election of a botanist was in contemplation. After looking the field over thoroughly, it was decided not to go outside of the Station staff in order to fill this position. The work of Mr. F. C. Stewart, who was located at Jamaica, L. I., pursuing investigations immediately related to the interests of Eastern New York, had been so satisfactory and promotive of practical benefit, that your committee having the matter in charge concluded to transfer him to the main Station, where he could have larger and more efficient facilities for the investigation of plant diseases. His work will now have a relation no less important to the agriculture of the Second Judicial Department than was the case under the former arrangement. Mr. Stewart has spent several months of the past year in Europe pursuing studies in plant pathology, returning to his work in August.

THE NEW BIOLOGICAL AND DAIRY BUILDING.

The most important accession to the Station buildings so far secured is the new laboratory which is designed to accommodate the departments of investigation along biological and dairy lines. Its erection was begun in September, 1897, and completed in September, 1898.

The accompanying description and cuts show as clearly as possible its appearance, construction and apparatus equipment.

The historical facts relating to the action of the Board of Control, legislation and the work of construction can best be presented by an extract from the report of the chairman of the building committee, Hon. A. C. Chase.

"On October 6, 1896, the Board of Control of this Station requested the director of the Station to prepare such plans as he might deem necessary for the erection of a building to accommodate the biological and dairy departments of this institution. At a subsequent meeting of the Board held in Albany on Janu-

ary 19, 1897, plans presented by the director were approved and it was unanimously voted to ask the Legislature then in session for $41,000, with which to erect the proposed building.

"This action was due to a clear recognition of the necessity for providing larger and more efficient quarters in which to locate the existing departments of dairy investigation, horticulture and entomology and the departments of botany and bacteriology to be created. The sum of money named was the estimate of the State Architect based upon preliminary plans which had been submitted to him.

"A bill framed in accordance with the action of the Board was introduced into the Senate by the Hon. John Raines and into the Assembly by the Hon. Murray Benham, gentlemen who ably represented this section of New York in the Legislature then in session, and who faithfully prosecuted and defended the interests of the measure which was placed in their charge.

"The bill was favorably reported from both the Ways and Means and Finance committees and received unanimous passage in both the Senate and Assembly. It was sent to the Governor about the middle of April and was approved by him on April 21, 1897. This act now constitutes Chapter 315 of the Laws of 1897.

"The unobstructed passage of this measure in a year when economy was the watchword and its signing by the Governor when it was entirely clear that many other requests must be denied are sufficiently noteworthy to call for some explanation. There was, first of all, a widespread and earnest representation to the members of the Legislature by many of their prominent agricultural constituents of the desirability of the proposed enlargement of facilities for investigation at the State Experiment Station. The State Grange, the State Dairymen's Association and several other prominent agricultural organizations passed resolutions favoring the erection of the proposed building.

"In the second place, those leaders in the Legislature who were in the position to exert a large influence upon legislation were

favorable to the measure. It is but just also to remark that the President of the Board of Control, occupying as he did a seat in the Assembly, was able to carefully guard the interests of the Station, and he was faithful to his opportunities.

"A committee consisting of A. C. Chase, S. H. Hammond, F. O. Chamberlain and W. H. Jordan was appointed by the Board to take charge of the construction of the building, and was authorized to make and execute all necessary contracts. Notwithstanding the fact that steps were taken on April 22d to secure plans and specifications from the State Architect's office, they were not placed in the hands of the building committee until nearly the middle of August, thus rendering it necessary to proceed with construction during cold weather. The committee promptly advertised for proposals for the erection of the building. Twelve were received which were opened on September 8th, the sums mentioned varying from $23,689 to $34,088.

"A. B. Morrison, of Geneva, was the lowest bidder and the contract was awarded to him at $24,214, this being an increase of $525 over the proposal on account of extras which were added to the original specifications. Later, proposals were received for installing the heating apparatus, the plumbing and drainage, the refrigerating plant, the temperature control system, the elevators, wiring the building and the lighting fixtures.

" The awards were as follows:

" Heating, Herendeen Mfg. Co., Geneva..........	$2,185 00
" Plumbing and drainage, Emig & Hatmaker, Geneva	3,475 00
" Refrigerating plant, A. H. Barber Co., Chicago....	2,000 00
" Temperature control system, Electric Service Co., of Buffalo....................................	1,145 00
" Elevators, The Houser Elevator Co., Syracuse.....	350 00
" Wiring buildings, Geneva Power and Electric Light Company....................................	425 00
" Lighting fixtures, Oxley & Enos Mfg. Co., New York city....................................	467 00

"Ground was broken for the foundations of the building in September, 1897, and the work proceeded as expeditiously as the conditions would allow.

"The style of the structure is certainly in keeping with its purpose, and must be commended for its quiet and simple dignity. The quality of the construction has been most thorough and satisfactory. This has not been due so much to the faithful and unrelenting inspection of the supervising architect, Mr. Charles F. Crandall, of Rochester, as to the ability and business integrity of the contractors. No matter how keensighted and insistent an architect may be, he is often unable to secure desirable results at the hands of irresponsible builders. This institution is fortunate in having entered into contracts with men whose honorable purposes rendered their bonds a superfluous legal form. The building committee takes this occasion to express its appreciation of the most excellent plans and specifications furnished by Hon. I. G. Perry, State Architect, of the faithful and efficient services of Mr. Charles F. Crandall, of Rochester, supervising architect, of the most thorough and elegant plumbing and drainage work installed after the plans and under the direction of Henri D. Dickinson, of New York city, and of the thorough and honorable execution of their contracts by the several contractors mentioned above."

General construction.— This new laboratory stands about 300 feet east of the Director's office, facing north and fronting upon North Street. It consists of a main building, 88 by 38 feet, and two wings extending 30 feet to the rear, between which is an open court at the rear 16 feet in width, insuring ample light and ventilation to all working parts of the building. The front is in three sections, of which the central one of 46 feet projects 4 feet. In front of this is a porch 9 feet wide and 41 feet long, with a veranda upon which doors open from the second story. The two stories, 11 and 10 feet in height, respectively, of both main building and wings are made of the best quality of cream-colored pressed brick, and trimmed with Medina stone. The basement extends under all parts of the building and is 11 feet clear, the con-

PLATE III.—BOTANIST'S LABORATORY.

crete floor being at grade in the rear, where doors into each wing, and into the main building from the court, give easy access. The elevators, one in front to the first story and one in the rear to both first and second stories, make the delivery of supplies and the handling of the dairy products very convenient. The basement and foundation walls are faced at all exposed points with Medina stone, giving a pleasing contrast with the lighter-colored brick. The roof is of slate, with galvanized iron cornices, and is so shaped that the attic rooms are large and high. Abundance of light is given these rooms through six double dormer windows at the sides, a round window in front and a skylight above.

The interior is finished in quartered oak; hard plaster is used throughout; and the floors are southern pine except in the vaults and four dairy rooms, where vitrified tile is used.

Heat, gas and water.—The building is heated by steam from two 30-horse power boilers in the basement, the radiators in each room being controlled by automatic valves connected with thermostats and operated by compressed air by the Johnson system. Steam from the boilers, compressed air and hot water from the compressor and heater (both also in the basement), and cold water and gas from the city systems are supplied at the laboratory tables and other convenient points. Constant pressure upon the water systems is maintained by connection with a 1,000 gallon tank in the attic.

Refrigeration.—For maintaining constant temperatures in the cheese-curing rooms and bacteriological culture rooms and a low temperature in the dairy and cold-storage rooms a supply of cold air is necessary. To secure this an extensive refrigerating plant has been installed. This operates upon the ammonia-expansion principle and consists of a compressor, oil-removing cylinder and condenser located in the basement; and expansion coils in one cheese room in the basement, butter room, pasteurizing room, cold-storage room and large insulated rooms in the attic. Part of these coils are immersed in brine tanks so that a low temperature, secured during the day, can be maintained during the night with-

out running the machinery. The power for the compressor and other machinery is furnished by a Straight Line, high speed, center crank horizontal engine which, at a steam pressure of 70 pounds and speed of 260 revolutions, gives about 25-horse power.

In refrigeration the gaseous ammonia is drawn from the expansion coils and passes through the water-jacketed compression cylinder where it is liquefied by a pressure of from 150 to 200 pounds. On its way to the cooling coils and tank the liquefied ammonia passes through a long, slender cylinder where by the action of gravity, it is freed from the oil used in lubricating the compressor. In the coils of the condenser the heat is drawn from the ammonia until the latter reaches the temperature of the city water surrounding the coils. From the cooling tank the liquid passes to the expansion coils as required, and by its rapid evaporation, controlled by expansion valves, withdraws the heat from the air or the brine surrounding the coils. The temperature can be reduced to a point far below freezing.

Departments and their equipment.— Handsome oak and glass doors lead into the entry from the front and from the entry into a central hall and staircase. Occupying the left side of the main building and the east wing are the five rooms devoted to horticulture. These consist, in succession from the entrance and all communicating, of the horticulturist's office, 18 by 15 feet, with a large dark closet attached; horticulturist's laboratory, 20 by 14 feet; assistant horticulturists' office, 20 by 17½ feet; assistant horticulturists' laboratory, 32 by 14 1-3 feet; and museum, 32 by 14 2-3 feet. The offices here, as throughout the building, are provided with large roll-top desks, revolving bookcases, specially planned and commodious wall cases and comfortable desk and office chairs, all the furniture being of oak. The laboratories each have a large work-table, with Alberene stone top and sink, fitted with the conveniences previously mentioned. The windows are provided with wide microscope tables or shelves, and these as well as the projecting ledges of the microscope and

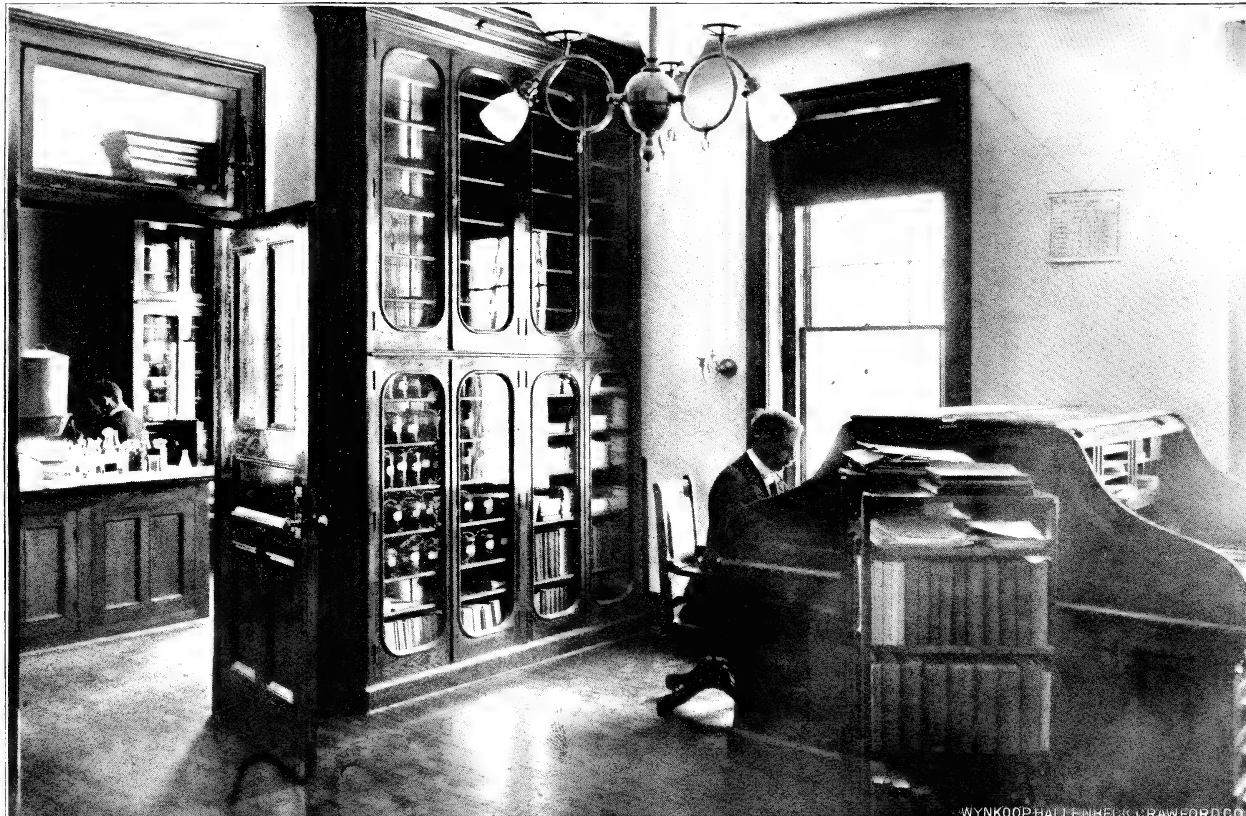


PLATE IV.—View in Office and Laboratory of Assistant Horticulturists.

reagent cases are fitted with removable glass tops to prevent staining. Adjustable spring-back chairs are also provided for the microscopists.

Facing the door of the horticultural museum and just across a narrow hall is one of the fire-proof vaults for the preservation of records, the other vault being upon the second floor, just above this one. The museums, also, are practically fire-proof.

The narrow hall referred to above is at right angles to the central hall but does not extend across it to the right. From this hall, upon the same side as the vault, lead the door and stairway to the basement.

At the right of the main entrance is the office of the dairy expert, which opens into another hall at right angles to the main one and leading to the butter room. This butter room is 32 by 20 feet in size and, like the milk-receiving room, pasteurizing room and cheese-room, is finished entirely in white. The floors of these rooms are of vitrified tile, with pitch sufficient to give ready drainage; and the sides have a wainscoting of enameled brick. The apparatus is also finished in white enamel, so that all the surroundings are conducive to neatness. In the south end of the butter room, next the milk-receiving room, are the four separators, a United States steam turbine, a United States belt power with intermediate connection, a DeLaval steam turbine and an Empire direct-connection belt power. Near the middle of the room is the box churn, which contains four compartments so that four samples of cream may be handled at once under uniform conditions. At the north end of the room are the hand and power butter workers with expansion coils above to secure proper temperature. This portion of the room can be shut off from the rest by a curtain when necessary. Opening from this room are an elevator to the basement, a large closet and the cold-storage room. The milk-receiving room has an outer door leading to steps extending along the side of the wing and contains a large vat and steam pump to receive the milk and distribute it to separators, pasteurizer or cheese vats.

In the pasteurizing room are the steam pasteurizer, milk cooler and Babcock tester. The upper coils over which the milk flows in the cooler circulate cold water and the lower ones ammonia, so that economical and rapid cooling is secured. The cheese room communicates by an elevator with the basement and with the second story near the cheese-curing rooms, and contains one large and two small cheese vats, one large constant pressure press and one small one.

Upon the second floor are found a central hall and staircase as below and the arrangement of rooms in the east half does not differ from that of the first story. These rooms are, in succession as before, the botanist's office, botanist's laboratory, entomologist's office, entomologist's laboratory and botanist's museum. The hall between the museum and vault, however, extends entirely across the building to the west wall and forms part of the insulation of the block of cheese-curing rooms. These cheese rooms occupy the west wing and are separated from its outer wall on all sides by a 4-foot passage-way. They are further insulated by double walls and air spaces on the outside and between the separate rooms. These rooms are six in number, each 9 by 10 feet, and each provided over the entire wall space with shelves 14 inches wide and 12 inches apart. It is expected to control the temperature in each of these rooms within 2 degrees, running each room independently and at any degree between 30 and 90. A hot-air flue from below and cold-air flue, from the chamber in the attic containing the expansion coils and brine tanks, lead into each room. These flues are closed by dampers operated by compressed air and controlled by thermostats. When the temperature falls one degree from the point fixed upon, the thermostat turns a valve and the compressed air opens the hot-air damper near the floor. Should the temperature rise, the cold-air flue in the ceiling is opened. So delicate is the operation of this system that breathing upon the thermostat will open the cold-air flue; fanning it, the hot-air damper.

In front of this second story and to the right of the center are

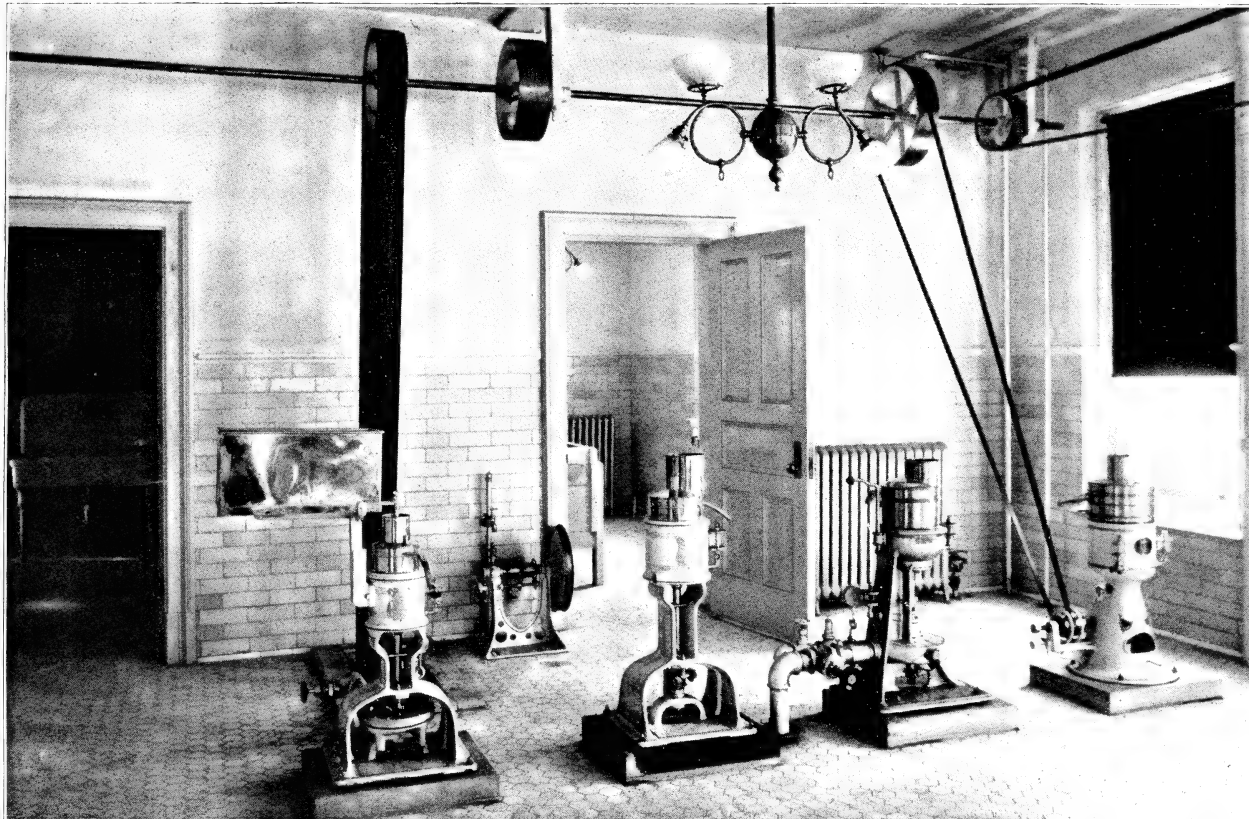


Plate V.—South End of Butter Room, Pasteurizing Room and Receiving Room

the bacteriologist's laboratory, bacteriological culture and incubator room and a storage and work room. A portion of the incubator and culture room is to be shut off from the rest by a glass partition and its temperature held where desired by a cold-air flue and radiator automatically controlled, as a convenience for summer work with gelatin cultures.

The attic has been finished off only in the east half and here are located the rooms devoted to photography. These consist of a gallery 36 by 34 feet, lighted by an 8 by 10 foot skylight and a large double dormer window; a dark room; and a finishing room.

In the west half of the attic is the chamber containing the large ammonia expansion coils and brine tanks. This chamber is insulated with great care by air spaces on all sides and by thick double-air-spaced walls, so that very little heat from without can enter.

In the basement are the machinery and boiler rooms, several large coal and storage rooms and one large room for curing Brie, cream, and similar cheeses which require moisture and darkness. This room is also provided with cooling apparatus.

USES OF THE BIOLOGICAL AND DAIRY BUILDING.

In order that the people of the State may be reminded of the real relation this new structure bears to agriculture as an art, I take the liberty of reproducing here remarks that I offered at the dedicatory exercises which occurred on September 21, 1898.

"It is not necessary to state what all clearly understand, that this building has not been erected simply for the sake of adding one more structure to those previously possessed by this Experiment Station. A larger and more useful purpose has been in view. What this is, doubtless many have asked to-day, in thought if not in word. It will aid in answering this very pertinent question if we refer to certain statements, contained in the report of the director of this Station for 1896. In discussing the proper work of this institution it was declared that 'horticulture and dairying occupy a commanding position in New York agriculture' and it

was subsequently stated that 'everything points, therefore, to the conclusion that the experiment stations of this State should give prominent consideration to whatever will promote these two lines of practice.'

"This building is one step in the pursuance of the policy thus enunciated. It is to harbor, as the report of the building committee states, the departments of dairying and horticulture, with those of botany, bacteriology and entomology, the three latter being really largely adjuncts of the two former. Dairying is an art, but it is one that is being materially modified by the results reached through chemical and bacteriological research. Horticulture is also an art, a many-sided one, and it is each year becoming more and more dependent upon the information supplied by the botanist and entomologist.

"Another statement was made in the director's report for 1896, which is also pertinent to this occasion, and which is quoted at length: 'If we base the reply to this question (How can the farmer's interests best be served?) upon experience, the answer must be that the farmer will best be served even from a business point of view by a rigid inquiry into the facts and principles which underlie his practice. The knowledge which, in its application to agriculture, has been in the past fruitful of the best results, is that which has come from investigations in the field of pure science, and this will undoubtedly be true in the future. Tests of theories and illustrative experiments in matters pertaining to the business of farming are useful and even necessary, but all safe and permanent advance must proceed primarily from a study of fundamentals. Judged in the light of these statements, then, the real function of the Experiment Station is to conduct severe scientific inquiry in those lines related to the practice of agriculture and, therefore, the controlling policy of this Station should be to strengthen and develop its facilities for making such research exhaustive and conclusive.' In providing these laboratories this Experiment Station is trying to live up to its declaration of prin-

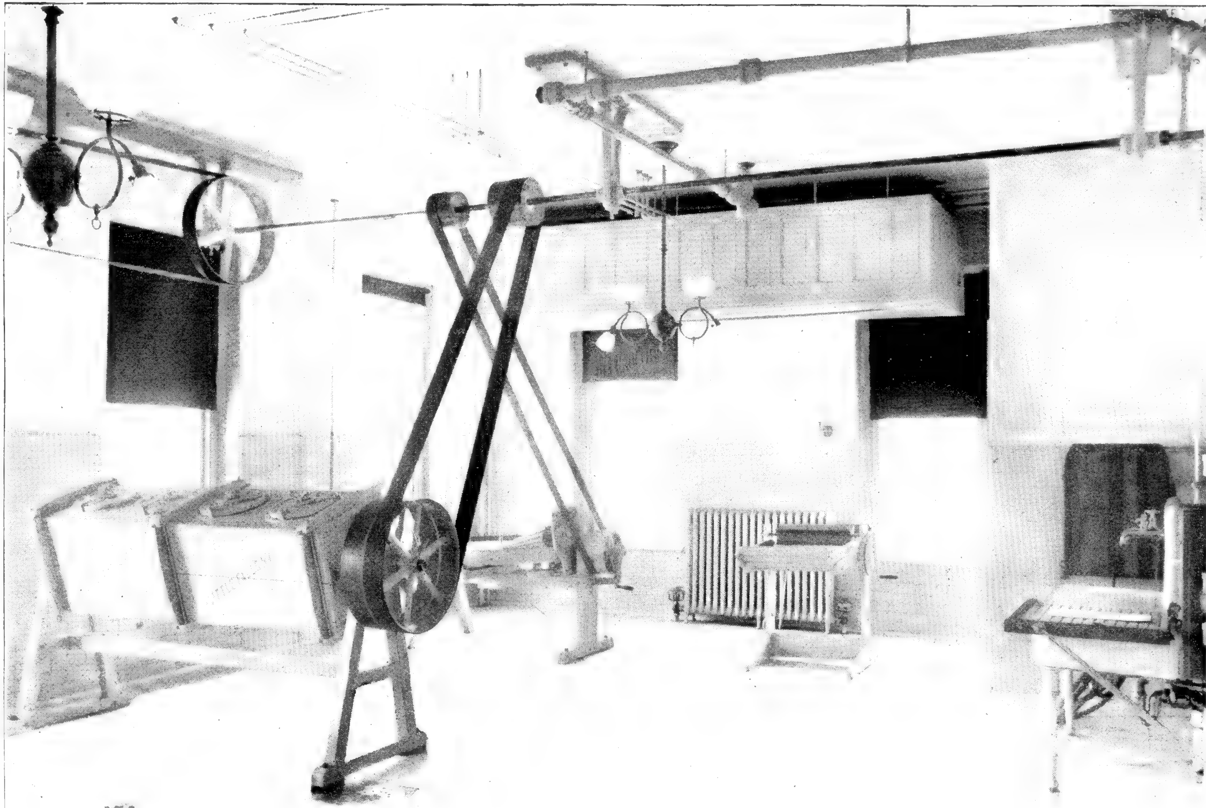


Plate VI.—North End of Butter Room.

ciples. What is to be the work of the horticulturists? Certainly not merely to study the cultural side of the fruit-grower's business, but to discover and formulate those laws of plant life which control all the practice of the garden and field. Prof. Beach will use the implements of research more than he will the pruning knife, however essential the latter may be.

"It is not expected that the botanist, Mr. Stewart, will devote himself wholly to naming new or unusual plants or to explaining how to eradicate weeds, but much of his time will be spent in searching out the hidden processes which have their course within the tissues of plants. The microscope, the sterilizer and the incubator will be his tools. The bacteriologist will also be a student of those minute organisms which seem to have so profound a relation to man's welfare, and this member of the Station's staff will be most useful when he is most scientific. Possibly he may spend days or months hunting for a single fact in the life history of one of these germs. The entomological laboratory is not built simply to contain a collection of 'bugs' although it is very important to have such a collection for reference purposes. Mr. Lowe will seek first for the life history of these little animals, both troublesome and useful, and when he is successful he will secure the data that are most valuable.

"We shall come nearest to the practice of an art in the dairy department, but the practical operations of the butter and cheese room will not be of a commercial character. Our dairy apparatus and our unique cheese-curing rooms are put into the hands of our dairy expert simply that he may co-operate with the chemist and bacteriologist in discovering the facts and principles fundamental to a proper control of manufacturing processes. Unusually fine equipment exists not to admire but to use in learning the effects of temperature and other conditions upon the compounds and organisms of our dairy products.

"Is any one skeptical about all this effort being of use to agriculture? He may quiet his fears, for the history of the past shows that the tiller of the soil will ultimately reap a benefit.

2

This building is also to have, we trust, an important relation to the higher range of human knowledge. No facts that pertain to the universe of matter and of life are useful to one art alone. The science which the farmer uses is science for the whole world, and is essential to every man who must both master and obey physical forces in the practice of an art or profession."

THE DEDICATION OF THE NEW BUILDING.

It would be a serious omission if the history of the Station for the past year was reviewed without mention of the dedication of the new building which occurred at the Station on September 21st. The circumstances attending that occasion were auspicious. The day was fine and the distinguished visitors who were expected to participate in the exercises were, in nearly all cases, Providentially able to be present. The attendance both local and from distant parts of the State was very gratifying. Probably not less than 3,000 people visited the Station grounds during the day. It was a collection of men and women representative of the best thought and effort in New York agriculture and their presence on that day in an attitude of sympathy towards the Station and its work was an encouragement and an inspiration.

In order to accommodate this large number of people, a tent with a seating capacity of 2,000 was erected adjacent to the Station grounds and it proved to be a very pleasant and convenient auditorium.

Addresses of a high order of merit were delivered here during both forenoon and afternoon. Good music was very kindly furnished by the Willard State Hospital band, for which favor I desire to make most appreciative acknowledgment.

The Station was especially favored on that day by the presence of Hon. James Wilson, Secretary of Agriculture, who, notwithstanding the severe pressure of great responsibilities, found time to personally express his interest in New York agriculture.

Among other distinguished gentlemen present were Congressmen S. E. Payne and James W. Wadsworth, Maj. H. E. Alvord

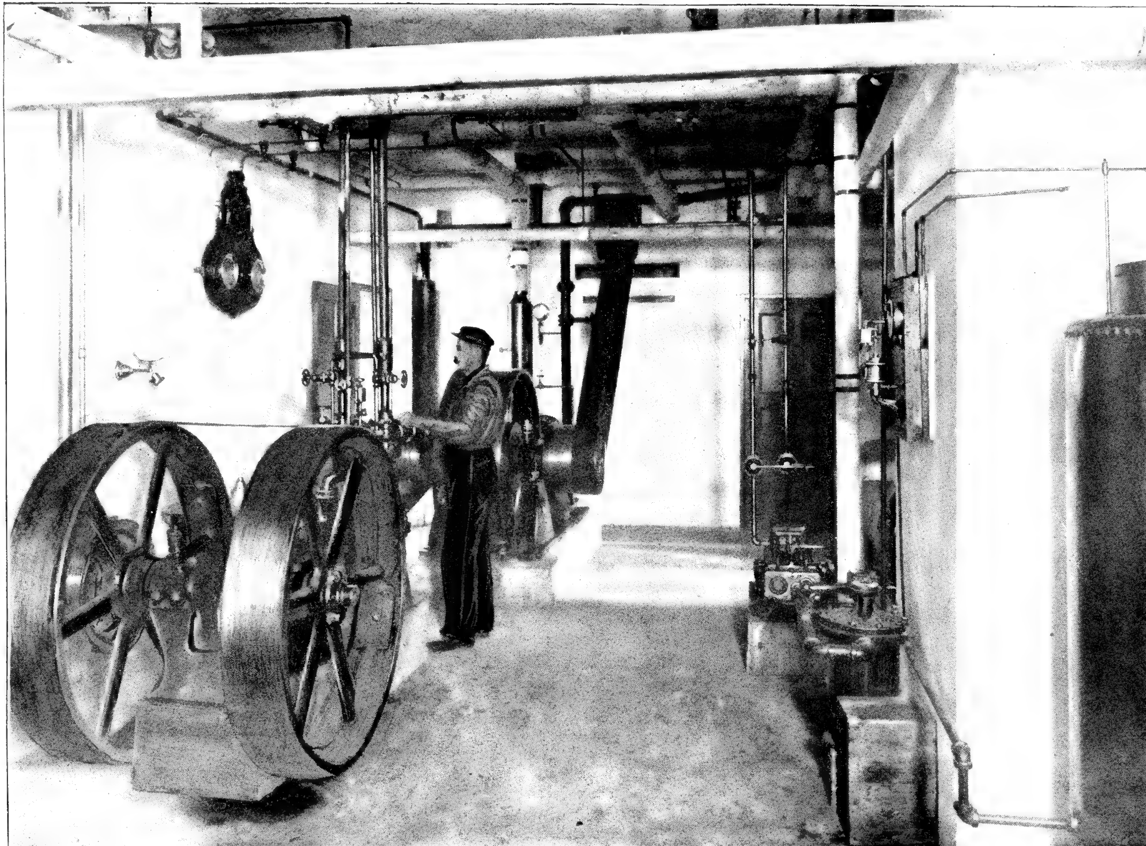


Plate VII.—Ammonia Compressor, Engine and Compressed-Air Pump and Tanks.

of the United States Department of Agriculture, ex-Gov. W. D. Hoard of Wisconsin, Hon. Charles W. Garfield of Grand Rapids, Mich., Senator John Raines, Hon. F. E. Dawley, Hon. S. B. Richardson of the State Department of Agriculture, Hon. A. R. Eastman, President of the State Dairymen's Association, Profs. I. P. Roberts, L. H. Bailey and H. H. Wing of Cornell University, Dr. R. E. Jones, President of Hobart College, Hon. Geo. E. Powell, and many other prominent agriculturists.

Special mention should be made of the presence of Prof. S. W. Clark and Hon. J. S. Woodward who were honored members of the first Board of Control of the Station when it was inaugurated some eighteen years ago.

Formal addresses were made by Secretary Wilson, ex-Governor Hoard and Mr. Garfield, President Jones, Prof. Roberts and Mr. Schraub, and remarks were offered by Congressman Payne and Senator Raines, to all of which the large audience listened with evident approval. The exercises of the day were highly complimented on all sides.

Outside of the speaking the new building was the center of attraction, although an elaborate display of fruit and the other buildings and equipment of the Station proved to be objects of general interest.

In the evening the reception given by the Board of Control was very largely attended, the rooms of the new building being crowded until a late hour.

A most excellent and comprehensive report of the entire proceedings of the day was made by an enterprising local paper, the Geneva Courier.

THE NEW POULTRY-HOUSE.

The new poultry-house is located where the only dry site was available, some distance from most of the other Station buildings. The size and general arrangement of this building are shown in the accompanying plan-drawing.

The central portion of the building is higher than the wings and has a basement, part of which is used for an incubator room and

part occupied by a hot-water heater and coal. From the incubator room two eight-inch ventilating pipes run to the loft. The first floor is used for a work room and one part as a sleeping room for the poultry man. The loft is used for storage.

Towards the end of the brooder wing are four pens in which can be used separate lamp brooders. A row of eight brooders is heated by pipes of hot water. Back of these brooders is a sunken passage-way connected with the heater room of the basement. This is covered by a trap floor which may be hooked back when desired. When working in this passage-way the brooders are at the height of an ordinary work bench. Four of the brooding chambers are 2 ft. by 3 ft. and four are 2 ft. by 4 ft. on the floor. Four flow pipes of hot water run through the brooders immediately over the chicks and two larger return pipes run underneath the tight floor. The brooders are separated by air chambers or boxes from which fresh air is admitted at each end of the brooder chamber through screened covered openings. Doors from the air box open into the passage-way so that pans of hot water to supply moisture may be placed on the return pipes.

These air boxes are not separated from the long inclosed space under the brooders through which the return pipe runs. A damper admits fresh air from the passage-way to the space under each brooder so that a current of air may pass under the floor of the brooder over the return pipes, then into the air box over the moisture pans and enter the brooding chamber near the flow pipes. The front of the brooding chamber is open, the floor being level with the floor of the pen, but can be closed when desired by a door of wire netting. The rear wall, partly of glass, is securely attached to the cover which is hinged and lifts against the partition. The brooder covers are strong so that collectively they form a raised walk. Wire netting doors open into each brooder pen.

The wing at the left contains a feed room and four pens for breeding stock. This wing has a tight-board ceiling. Trap doors open into the loft and ventilator pipes extend through the roof. A pipe connected with the water heater runs through this wing

PLATE VIII.—AMMONIA COILS AND BRINE TANKS.

along the floor under the water dishes and nests, so it is possible to warm the room slightly if desired during very cold weather. The sides at the rear and the outer ends of both wings are double, inclosing an air space. The windows in each wing are of one sash and hinged at the side so that they serve as doors to the open runs. Storm windows are fitted to button on outside for use during cold weather.

OTHER BUILDING IMPROVEMENTS.

Some years ago a large water-tight manure platform, about 100 by 40 ft., constructed of grouting and cement, was built just south of the cattle barn. Under this platform water-tight cisterns were located to catch all drainage from the manure. As this platform had no covering, and as the records of sixteen years show the rainfall of this region to vary from twenty-two to thirty-six inches annually, it is plain that approximately from 230 to 375 tons of water would fall annually on this platform, a large part of which would run into the cisterns. In order to make available the plant food taken into solution, all this rain water must be pumped into carts and distributed on the land, thus incurring an expense much greater than the value of the plant food leached from the heap of manure. In view of these facts, a manure shed has been built over this platform. The wisest method of saving manure is to use sufficient absorbents behind the cattle, and then if the manure is stored, to keep it sufficiently moist and compact to prevent excessive fermentations.

This shed is so placed with relation to the new piggery mentioned later, that if it seems wise, the swine will be given access to the manure, thus securing the desired compactness.

A new piggery, designed to accommodate twenty or thirty swine, has been erected adjacent to the manure shed. This was made necessary by the need of proper and convenient storage space for farm machinery which can now be found in the basement of a barn formerly used for swine. This basement is to be renovated and finished with a grout and cement floor and used for storing the smaller implements and machinery when not in use.

An important change has been made in the basement of the cattle barn by doubling the window space and by substituting a wooden wall for the stone masonry in the south end. With the increased light and dryness thus secured this basement appears to furnish comfortable and healthful quarters for live stock.

In view of the need for much more milk to be used in the new dairy building, it will be necessary to enlarge the stock capacity of the cattle barn. This can only be done by building a wing, one story probably, and most conveniently on the east side, that will accommodate twenty or thirty animals. I recommend that $1,500 be secured for that purpose. I also recommend that $1,000 be secured for the maintenance of general repairs to the Station buildings. The general funds appropriated for the use of the Station should be wholly applied to the maintenance of its various departments and must be if it is conducted along the varied lines that are now undertaken.

THE STATION PUBLICATIONS.

A recent count of the names on our mailing list shows that the popular bulletins are being distributed as follows:

Popular Bulletin List.

Residents of the State of New York	29,697
Residents of other States	716
Newspapers	732
Experiment Stations and Experiment Station staffs	814
Miscellaneous	131
Total	32,090

The complete bulletin list is comparatively small.

Complete Bulletin List.

Experiment Stations and officers	752
Libraries, scientists, etc.	136
Foreign list	52

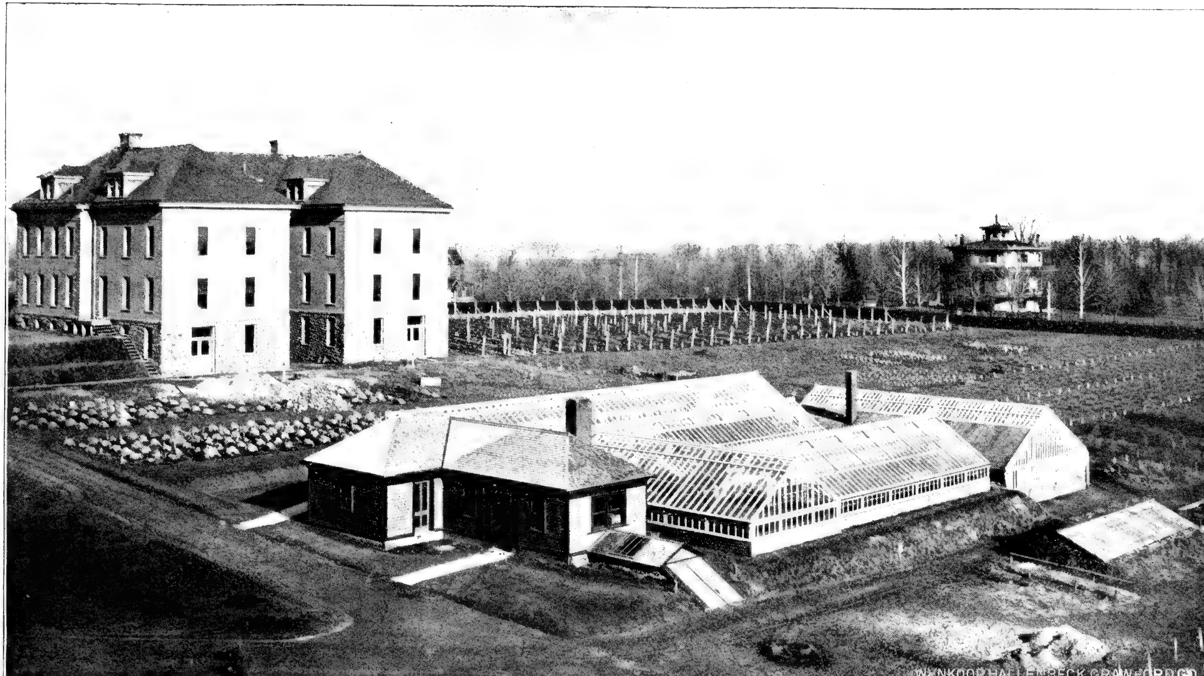


PLATE IX.—BIOLOGICAL AND DAIRY BUILDING AND FORCING HOUSES.

Individuals	290
Miscellaneous	131
Total	1,361

It has now been nearly two years since the Station began the publication of the so-called popular bulletins. So far experience seems to justify the decision to issue this form of publication. A few criticisms have been met, but as a rule the opinions expressed have been those of approval. The relative appreciation of the complete and popular bulletins may be judged by the requests for the former which are sent to the Station. Every copy of a popular bulletin contains a statement that if the recipient prefers the complete bulletins they will be sent to him regularly. Notwithstanding this offer, less than 300 such requests have come from more than 30,000 persons.

The Station mailing list is steadily growing. During the last five months it has increased over 800 names, mostly in response to requests sent to this office.

RELATION OF THE STATION STAFF TO FARMERS' INSTITUTE WORK.

There are various instructional and research efforts now maintained in the interests of farmers, whose lines more or less intersect. The teachers in our agricultural colleges are to some extent investigators and they are found often on the institute platform. The experiment station worker, whose chief function is to investigate, is frequently taxed severely by requests to serve as an institute speaker, as well as to give class room instruction, when the experiment station is a department of a college. This interrelation of these distinct but at the same time closely related lines of effort is often the occasion of more or less perplexity.

The State of New York is maintaining an extensive system of farmers' institutes, requiring the services constantly during the winter months of a large number of speakers. The persons who

are qualified to act in this capacity are in the main only those who can speak attractively with authority concerning some special subject important to agriculture. Such popular teachers are not abundant. For this reason, the members of this station staff are constantly sought, not only by the officials who have the institutes in charge, but by the farmers themselves, to appear on institute programs, a condition of affairs which looked at from one point of view is a proper cause of gratification. It is an omen of good that the agricultural masses have come to regard the truths of science as useful to them and their art. It is fortunate, also, that the scientists at an experiment station have the opportunity to come into sympathetic contact with those in whose interests they are working. A personal relation is thus established which is promotive of mutual confidence and understanding. Besides, while the farmers may learn much from the student of science, the latter may in return gain from the practitioner new views of the relations of truth to the art he is seeking to benefit, and thus be guided in giving to his researches the direction of greatest usefulness.

It is necessary, however, in order to understand the situation to view this matter from another standpoint.

The primary function of an experiment station is investigation, not instruction. This statement may disagree with popular opinion, but it is nevertheless correct. This being true, there are two facts which it is important to consider:

1. Frequent calls, at intervals more or less distant, for service as speakers at institutes, is a serious encroachment upon the mental status and consecutive effort of the investigator. This is true both with reference to laboratory study and to the discussion of results.

The chemist, the botanist or the bacteriologist, when once he has entered upon a series of observations is seldom able to turn aside to other matters without serious loss, and when in the midst of the discussion of results, with his mind saturated with the data he is to present, he cannot temporarily transfer his mental

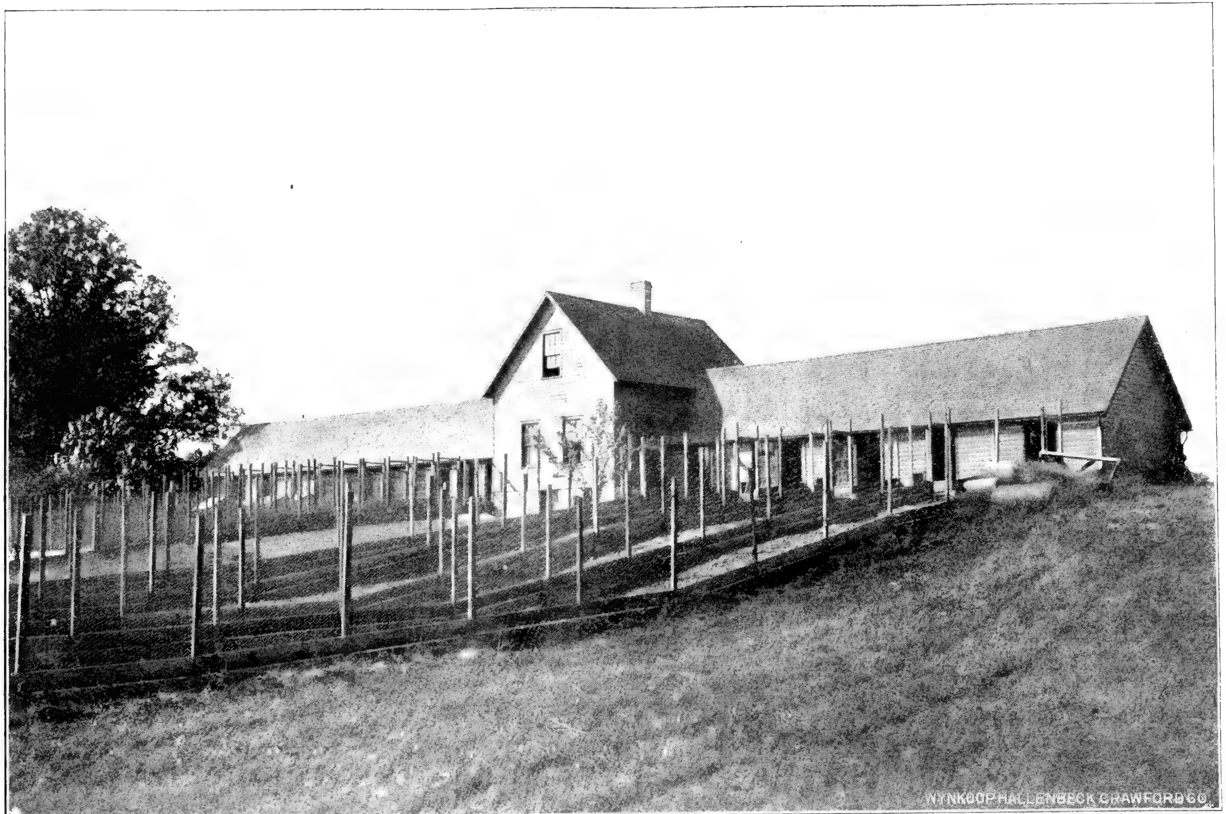
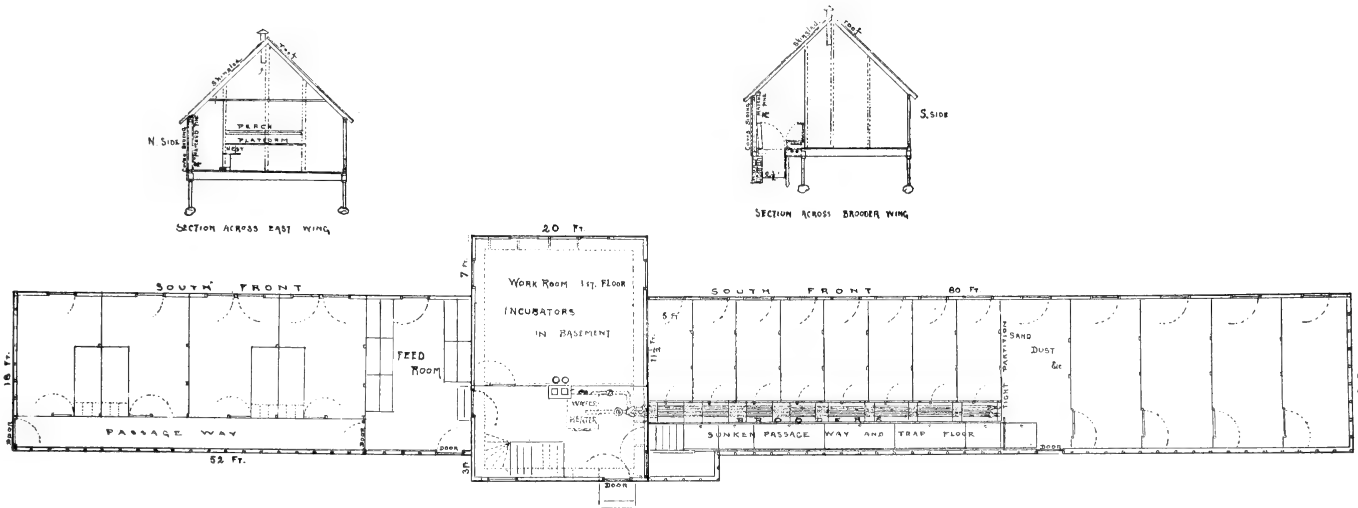


PLATE X.—REAR VIEW OF NEW POULTRY PLANT.



GROUND PLAN OF POULTRY HOUSE

FIG. 4.

activity to another subject without seriously checking his momentum along the main line of thought.

2. The teaching habit, especially in a popular way, cannot be considered as an aid, and may easily be a hindrance, to the close analytical mental processes along technical lines which are essential to success in scientific studies. This may explain why the platform efforts of many of our ablest men of science, who seldom attempt popular discussions, are characterized as "dry," while on the other hand the scientist who gives himself over to cultivating popular ways of speech and thought often finds himself drifting away from a love and aptitude for severe research. It is not impossible, nor perhaps very unusual, for men of scientific attainments to be efficient public speakers, but nevertheless we cannot ignore the essential difference between the mental status required for popular instruction and that necessary to rigid scientific inquiry.

Certainly that statement so often heard that contact with the people is necessary to the investigator is not substantiated either by theory or observation. Some of the most profound and useful discoveries in science have been reached by men who seldom emerged from their laboratories, and certain American experimenters whose efforts have been fruitful of important results are those who are seldom heard in public.

The situation in New York is such as to require a careful adjustment between the experiment station and the institutes in order to best promote the success of both. On the one hand farmers should not assume that the members of the station staff are most useful to them when they speak from the platform, because this is seldom true. They should not be too insistent in their demands for platform effort. On the other hand some systematic and well understood arrangement should be made so that the station workers can anticipate interruptions and thus make such plans as are necessary to an economical use of time. If one of the station staff is to address ten institutes he should be allowed

to do this as nearly consecutively as possible. It is easily possible to spoil a month's time for this amount of speaking where only one or two days are used in a week. The above statements are made with a full recognition of the strong sympathy which exists between this station and the institute effort, and of the greatly increased strength and influence this institution has gained from the opportunities which are made possible through the helpful attitude of the Director of Farm Institutes.

WORK IN THE SECOND JUDICIAL DEPARTMENT.

This work, during the year 1898, was directed chiefly towards the care and production of three crops, potatoes, cucumbers and onions, which are very important ones in Eastern New York. The experiments conducted have involved during 1898 the use of approximately 20 acres of land located at various points in the Second Judicial Department. It is seldom that experimental work is productive of results more highly and immediately useful than has been the case with those relative to the use of fertilizers on potatoes and of fungicides and insecticides on potatoes and cucumbers. These results as related to potato growing and cucumber blight are fully presented in the Station bulletins and are to some extent reviewed on subsequent pages. Experiments on the prevention of onion smut have been in progress two years and will be continued longer before an attempt is made to formulate conclusions. Experiments in the production of chestnuts were also begun two years ago, concerning which nothing will be published at present.

CHEMICAL DEPARTMENT.

Fertilizer inspection.— In my report for 1897, attention was called to the unsatisfactory condition of the sale and inspection of commercial fertilizers. It was stated that the brands of fertilizers have increased to an absurd number without thereby serving any good purpose but rather causing confusion and unnecessary expense. The situation has grown worse rather than better.

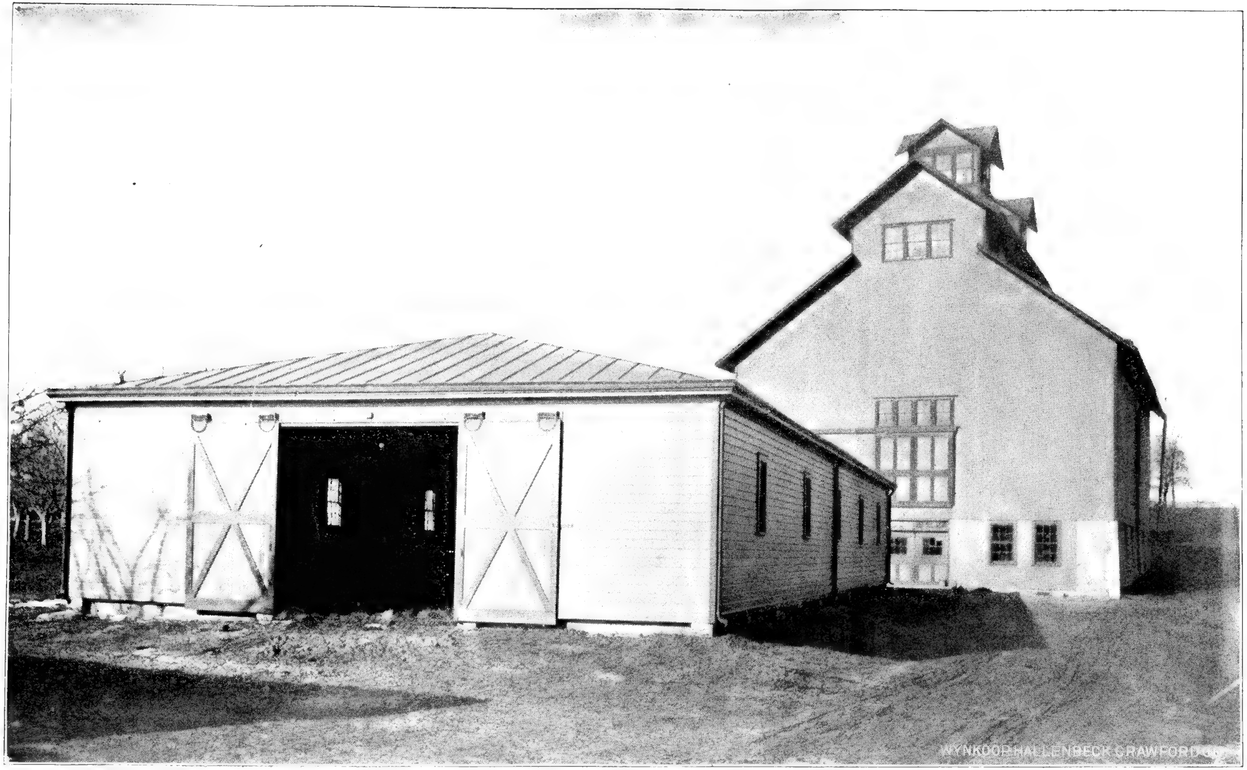


Plate XI.—Manure Shed.

In 1898, 1,900 brands were registered in this office and the Station actually collected for analysis 1,427 samples representing 901 brands, at an expense greatly above the money appropriated by the State for this purpose. No such burden is laid upon an experiment station in any other State simply because in all other States the fertilizer trade, either through a license fee, analysis fee or a ton tax, pays the expenses of inspection. In New York the State is assessed, and manufacturers, without additional expense to themselves, may add a new brand, even if not more than a carload is sold. If the creation of the new names had any significance or value whatever, there would be less cause for criticism. As it is, hundreds of the brands sold in New York are essentially alike in the plant food which they furnish, nearly all of the so-called special fertilizers having no scientific or practical justification. It is not necessary to create a new brand every time a farmer or body of farmers wishes for a particular mixture of plant food, neither is it necessary to humor the desire of every local trader for a brand in his name, thereby causing large expense to the State.

In view of this situation I recommend that the Legislature of 1899 be asked to require the payment of a license fee for each brand of fertilizer put upon the market. Out of twenty-nine States which require fertilizer inspection New York is the only one which pays the expense from the State treasury.

I desire in this connection to call especial attention to certain facts presented by Dr. Van Slyke in Bulletins 145 and 148, relative to the fertilizer trade.

Few matters are more important to agriculture at the present time than is the extensive traffic in plant food. It is estimated by the U. S. Department of Agriculture that in 1896 there was sold in the State 150,000 tons of fertilizers at a cost to the farmers of $4,621,500. But one other State is a larger consumer of these goods than is New York, due in part to her extensive market gardening interests. Without discussing the question whether so large a purchase of plant food is wise or even necessary, it is

safe to affirm, on the basis of the facts contained in the above-mentioned bulletin, that this expenditure might be materially reduced by improved methods of buying, methods which require no unusual knowledge or intelligence.

Dr. Van Slyke shows that the fertilizers sampled in the spring had an average selling price \$9.13 in excess of the commercial valuation, the excess in the case of the fall goods being \$5.28. This was nearly 50 per cent of the commercial valuation of the spring goods and 33 per cent the fall goods. Now it is an actual fact that farmers' clubs, or even individual farmers in New York not too remote from railroads, can purchase nitrogen, phosphoric acid and potash delivered at their farms, for not more and often for less than the prices named in the schedule of valuation. In the case of phosphoric acid in acid phosphates it can now be bought at a price below the valuation named, viz., 4½ cents per pound. Very recently phosphoric acid has been delivered to buyers in Central New York through an agent of the manufacturers at less than 4 cents per pound. As a matter of fact thousands of tons of fertilizers are now purchased annually in this State greatly under the usual retail cost of similar goods. Farmers often write to the Station, naming sums at which they can buy certain mixtures of local agents, prices which are positively extortionate, and the remedy lies either with the club system or in the purchase of unmixed materials to be mixed on the farm. Many of the 195 individuals and firms who register as manufacturers are not really such; they are only mixers; that is, they buy acid phosphate, potash salts and nitrogenous materials and mix them together in various proportions, give names to the different combinations and then retail them to the farmers. All this is unnecessary. Farmers can do their own mixing, and the interposition of the so-called manufacturer adds nothing to the value of the plant food purchased. Many of the real manufacturers stand ready to sell the chemicals and raw materials separately or compounded in any proportions desired, and hundreds of farmers are now taking advantage of this opportunity.

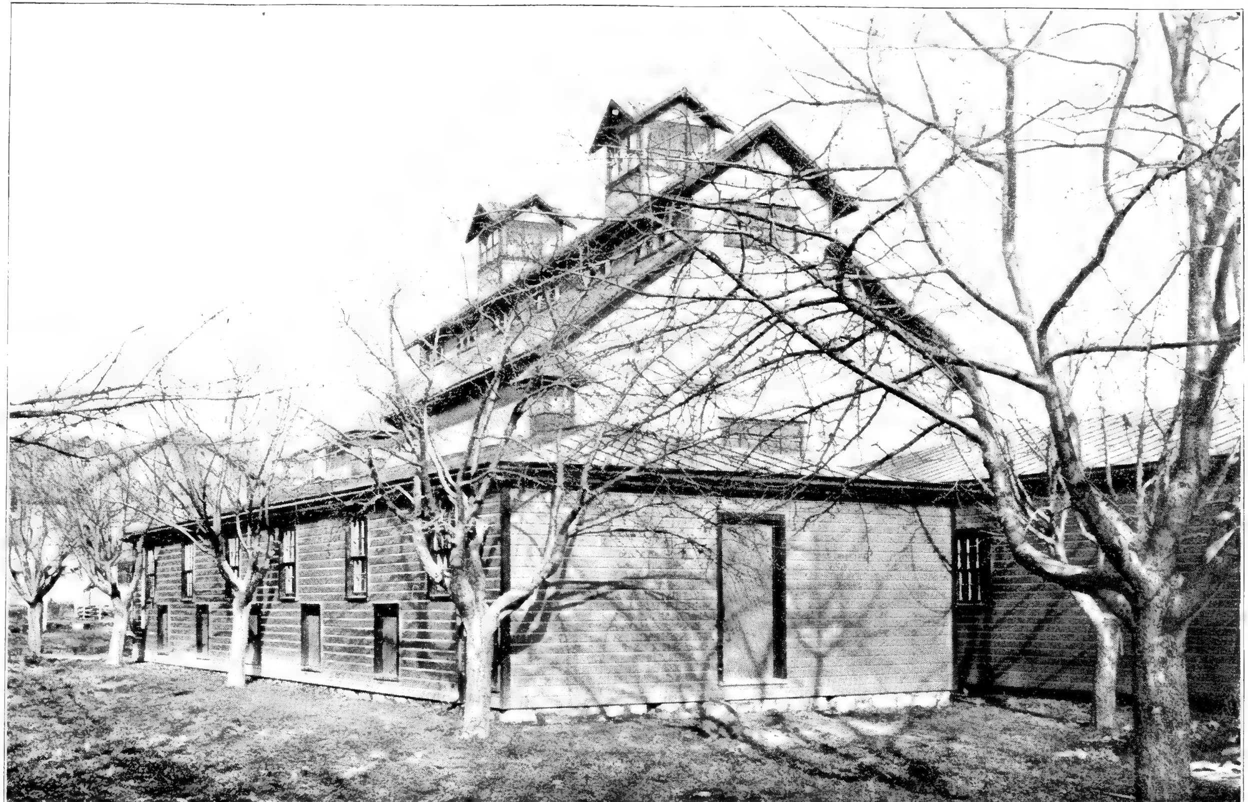


Plate XII.—New Piggery.

Sugar beets.— During the past season, much attention has been given to the sugar beet crop. Besides somewhat elaborate experiments on the Station farm, we have co-operated with 18 farmers growing half acres of beets in eleven counties in Central New York, and have distributed small quantities of seed to a large number of other farmers. In all, 343 samples of beets have been analyzed, including those from the Station experiments and those grown from seed distributed by the Commissioner of Agriculture in Eastern New York. The observations of 1898 are in line with all previous records. In quantity and quality New York beets appear to compare very favorably with those produced in other parts of the world.

COMPOSITION OF SUGAR BEETS GROWN IN 1898.

Total of season's results, 343 samples:

	Sugar in beet.	Sugar in juice.	Purity of juice.
Lowest	7.4	7.8	64.1
Highest	20.2	21.2	90.0
Average	14.2	15.0	85.2

The yields reported from the plats grown by farmers in co-operation with the Station varied from 8,670 to 58,990 lbs. per acre, the lowest yield being on plats receiving no fertilizer and the highest occurring on muck land, the average being 26,720 lbs. In these experiments the average per cent of sugar was 15.5 per cent, which is over 1 per cent higher than the general average for 33 counties, which is probably due not so much to location as to better conditions of growth and culture.

The figures given as the cost of growing these beets are chiefly valuable as showing the distribution of time, the expensiveness of neglect in one or two cases and of a general unpreparedness for the work. Should the growing of sugar beets become generally established, experience and the possession of better machinery would certainly considerably reduce the labor cost of the crop, especially with large areas.

It is fair to remark, also, that if a careful record were kept of the labor expended in growing other crops, long established, the relation of cost to production might in many cases appear to be unfavorable to profit. We are applying to the sugar beet crop a record and analysis of cost in a way not generally attempted with general farm crops, which is somewhat unfair in an effort to judge of relative profits.

It is somewhat doubtful whether widespread experiments on limited areas, such as have been conducted for two years, can be continued profitably. Such experiments will hardly furnish reliable evidence concerning anything more than the quantity and quality of beets produced, and with regard to these two points we are now warranted in reaching conclusions. The work of the experiment station in the future should be confined to a study of certain problems of production as affecting quality and yield.

For instance, we have been taught that farm manures should not be applied to land in the spring prior to growing a crop of sugar beets, and that the use of large quantities of nitrogenous fertilizers is antagonistic to high quality.

Experiments on the Station farm and on that of Mr. Dawley do not support these conclusions. On the Station farm, beets grown on land to which was applied in the spring 10 cords per acre of barn manure were as a whole richer than those with or without commercial fertilizers, were healthier and in appearance were a more satisfactory crop. Large additions of nitrogen as nitrate of soda and dried blood did not appear to depress the proportion of sugar. These observations should be continued in order to establish the facts, and other problems of equal interest wait for solution.

The difficult questions which confront the beet sugar industry in this country are now those of a commercial character which relate to production and manufacture. To be sure farmers need to be educated in methods, but nothing will accomplish this so effectually as actual experience in growing beets in a commercial

way. Manufacturers will find, too, that the real conditions of their business are different from those previously displayed on paper. Moreover, the relations between the farmer and the manufacturing plant are likely to be for some time the occasion of wide differences of opinion before a generally recognized business basis is reached.

DEPARTMENT OF HORTICULTURE.

Tests of varieties from foreign sources.— In the spring of 1898 at the request of Mr. D. G. Fairchild, special agent for plant and seed introduction for the U. S. Department of Agriculture, Washington, D. C., the Station undertook to test a large number of melons and a few other vegetables, seeds of which had been imported through Prof. N. E. Hansen who visited East Europe, Siberia and Northwest China in 1897 for the purpose of collecting for the Department seeds and plants which seemed likely to be valuable in the semi-arid regions of this country.

In the collection of seeds which were sent to this Station there were about ninety varieties of Russian muskmelons and watermelons, besides a number of kinds from Asia. Seeds of pumpkin, sweet corn, turnip and six varieties of cabbage were also received.

Arrangements were made to test these vegetables at Geneva and to duplicate the tests on Long Island. The cabbage and turnip were tested under the direction of Mr. C. L. Allen of Floral Park, to whom we are indebted for many courtesies. Mr. Allen is well known as an authority on *Brassicas*. The other vegetables were tested at Southampton under the direction of Mr. F. L. Greene, a graduate of the Massachusetts Agricultural College.

In every instance the crops were grown on soil naturally well adapted to their culture and the ground was carefully prepared, fertilized sufficiently to provide for a vigorous growth and given good cultivation. At Geneva the melons were started on inverted sod under glass and not transferred to the field till warm weather

was established. On Long Island, where the season is longer, the seeds were planted in the field.

As a result of the season's work it must be said that but one variety in the whole list proved to be really promising, and that was one of the cabbages. Mr. Allen reports that it is a variety of the Flat Dutch or Drumhead type, producing a very deep and solid head, a strong grower, and after a few generations grown in this country would probably develop a very useful variety, particularly for the South and West. The other cabbages were some of them mixed, others were inferior strains of varieties already known here, and the rest were not at all promising. The turnip was an inferior type of ruta baga.

Of the Russian melons which were successfully fruited one ranked good in quality, eleven ranked fair to good, fifteen were only fair, twenty-four were poor and thirteen ranked from poor to fair or good with different specimens. Twenty-four were selected as possibly worthy of further testing. Ten kinds of seed gave mixed variety of melons. The record of the Asiatic melons was even more discouraging than that of the Russians. They seemed to be especially subject to disease, and the fruit, when any was obtained, ranked far below that of American kinds which were grown beside them for comparison. The Russian melons also appeared to be more subject to disease than the American sorts. Notwithstanding several treatments with Bordeaux mixture the anthracnose did much damage, and together with the bacterial disease injured many kinds so seriously as to prevent the development of perfect fruit.

Fertility of grapes.— It has been found that many varieties of cultivated grapes are self-sterile; others are imperfectly self-sterile, that is to say when cross pollination is prevented they form clusters which are more or less imperfect; others are fully self-fertile. The last class includes nearly all the varieties which have proved satisfactory in commercial vineyards.

Investigations concerning the self-sterility of grapes have been

conducted at this Station since 1892, and in 1897 the tests were repeated with several varieties in two localities in the vineyard region of Western New York.

One hundred and sixty-nine cultivated varieties have been included in these tests together with a few vines representing uncultivated native species. Eleven species have been under investigation.

Different kinds of flowers are found with the grape, *Vitis*, but each vine normally bears only one kind. The so-called male vines produce no fruit for they bear staminate flowers only, having no pistils or, at most, rudimentary pistils. These flowers have long stamens. All fruitful vines bear perfect flowers, having both stamens and pistil. These may be separated according to the structure of their flowers into three classes, those with short, recurved stamens, those with long, upright stamens, and those with stamens intermediate between long and recurved.

Flowers with long stamens are structurally adapted to insure self-pollination. The short, recurved stamens do not favor close pollination.

Forty-seven varieties having short stamens were tested for self-fertility. When cross-pollination was prevented only eight set any fruit, and none of these formed perfect clusters. In many cases varieties having long stamens were self-sterile, the pollen being self-impotent. Short stamens are, so far as known, a reliable indication of partial or complete self-sterility. It cannot be said that long stamens are a sure indication of self-fertility.

Lists of self-sterile, partly self-fertile and self-fertile varieties based on the experiments referred to are published in a bulletin. When self-sterile or partly self-fertile varieties are cultivated they should be mingled with other varieties so as to favor cross-pollination.

Tables have been prepared from the records of the Station vineyards whereby the date of blooming of the different varieties may be compared. This will assist those who wish to grow any of the

self-sterile varieties in deciding what varieties may be mingled with them to provide for cross-pollination.

Ringing grapevines.— Conclusions drawn from results of experiments are as follows:

Vines should be vigorous and not be ringed too severely.

A ringed vine cannot carry as large a crop of fruit to maturity as an ungirdled vine.

Vines grown on renewal system should have all arms ringed and all fruit back of the ring should be removed. Fruit on unringed arm is inferior, while fruit back of a girdle is worthless.

With many varieties, when properly done, ringing does not seriously injure the quality of the fruit.

Not all varieties should be ringed.

Too severe ringing will kill the vines.

With some varieties and in some seasons girdling will hasten time of ripening 8 or 10 days and in some cases increase size of bunch and berry at least a half.

DEPARTMENT OF BOTANY.

Spraying experiments on cucumbers.— During the season of 1898 co-operative spraying experiments on late cucumbers were conducted in four different localities on Long Island: Green Lawn, one and one-half acres; Smithtown Branch, two acres; Deer Park, two acres; and Mattituck, two acres. Owing to lack of fertility in the soil, the experiment at Mattituck was a failure. At the other three places the sprayed fields remained practically free from the downy mildew or "blight" and gave an average yield of 86,000 marketable cucumbers per acre, while unsprayed fields in the same localities and under approximately parallel conditions yielded on the average about 35,000 per acre.

From the results of experiments made during the past three seasons we are convinced that the spraying of late cucumbers on Long Island is a highly profitable practice.

DEPARTMENT OF ENTOMOLOGY.

The collection of insects.— This collection, which is steadily growing, has been reclassified under the direction of the Entomologist, by Miss Alice M. Beach, whose work deserves special mention as it was exceptionally well done. The block system is used. Supplementary to this collection a collection of plants and portions of plants is being made showing the injury to the plants caused by noxious insects.

Experiments to determine the effects of hydrocyanic acid gas upon the eggs of insects.— These experiments have not been completed. A large number of eggs, especially of certain common species of plant lice, have been fumigated, however, the time of exposure to the gas varying from ten minutes to one hour. The results so far indicate that the eggs of such insects as plant lice can be destroyed by fumigation with hydrocyanic acid gas, a matter of importance to the nurserymen.

The grapevine flea beetle.— Investigations into the life history and habits of this insect have been begun with the result that new facts relating to its life history have been ascertained. Preparations have been made for more extended experiments another season than there was opportunity for during the past summer.

Spraying experiments with arsenite of lime against the canker worm.— These are a continuation of the experiments of last year. Excellent results were obtained with the arsenite of lime made after the Kedzie formula. The experiments were made in an apple orchard at Rushville owned by Mr. O. L. Jackson. Three applications of the poison were made with the result that the infested trees were practically freed from the canker worms.

The apple-tree tent-caterpillar.— The life history of this insect has been studied during the past season and observations made as to its natural enemies. Nearly 80 per cent of a large number of cocoons collected were parasitized. Six species of parasites were reared in the laboratory from these cocoons.

The raspberry saw-fly.— The life history of this insect has been studied and experiments made to ascertain a remedy. Good results were obtained with hellebore. Original observations have been made upon the various stages of the insect's life, especially the larva, pupa and the adult male.

The San José scale.— Extensive experiments against this insect have been begun. The experiments include tests with pure kerosene oil and kerosene oil mechanically mixed with water in the proportions of 20 per cent and 40 per cent oil, also whale oil soap solution and a solution of caustic potash at various strengths. In the experiments with kerosene oil, a large number of healthy nursery and orchard trees of various varieties have been sprayed to ascertain the effect of the kerosene oil upon healthy trees.

DEPARTMENT OF ANIMAL INDUSTRY.

The economy of using animal food for poultry.— A number of feeding experiments have shown almost invariably an advantage in the use of rations containing animal food over rations consisting entirely or largely of vegetable food. The data from some of the experiments made to determine the relative efficiency of vegetable and animal food have been published. The points brought out by these data are indicated in the following summary.

A ration in which about two-fifths of the protein was supplied by animal food was much more profitably fed to chicks than another ration supplying an equal amount of protein mostly from vegetable sources but supplemented by skim-milk curd.

When the two rations were fed to cockerels also, the results were favorable to the animal food, but the difference was not so pronounced as with the chicks.

Pullets fed the ration containing the large proportion of animal food attained ultimately somewhat the larger average size, but the chief advantage over those fed the contrasted ration was in the more rapid growth and earlier maturity.

With ducklings much the better results accompanied the feeding of a ration in which about half the protein was supplied by

animal food. The growth was over three times as rapid as under another ration in which most of the protein was of vegetable origin with enough skim-milk curd added to supply about one-fourth of the total protein.

In the general vigor and health of the chicks there was some difference in favor of the animal food ration. This difference was very pronounced with the ducklings.

PRODUCTION OF FIELD CROPS.

The experiments on Long Island in the use of commercial fertilizers on potatoes have been continued with some enlargement. Three acres of land are now in use on each of four farms. A fertilizer experiment with onions was also carried on in 1898. Twelve acres of land on the Station farm are now devoted to a somewhat elaborate study of methods of maintaining fertility, and although two years' results are already in hand, nothing will be published for some time, perhaps not for several years.

BULLETINS PUBLISHED IN 1898.

The following is a list of the bulletins issued by the Station for the year 1898:

No. 143 — April.— Cottonwood leaf beetle. Green arsenite. V. H. Lowe. Pages 24, plates 6.

No. 144 — September.— A spraying mixture for cauliflower and cabbage worms. F. A. Sirrine. Pages 23, plates 6.

No. 145 — September.— Report of analyses of commercial fertilizers for the spring of 1898. L. L. Van Slyke. Pages 101.

No. 146 — November.— Some experiments in forcing head lettuce. S. A. Beach. Pages 29, plates 4.

No. 147 — December.— Variety tests of strawberries, raspberries and blackberries. Wendell Paddock. Pages 18.

No. 148 — December.— Report of analyses of commercial fertilizers for the fall of 1898. L. L. Van Slyke. Pages 27.

No. 149 — December.— The economy of using animal food in poultry feeding. W. P. Wheeler. Pages 20.

No. 150 — December.— I. The raspberry saw-fly. II. Preliminary notes on grape-vine flea-beetle. V. H. Lowe. Pages 17, plates 7.

No. 151 — December.— Experiments in ringing grape-vines. Wendell Paddock. Pages 12, plates 2, fig. 1.

No. 152 — December.— Two destructive orchard insects. V. H. Lowe. Pages 25, plates 4, figs. 2.

No. 153. — December.— Director's report for 1898. W. H. Jordan. Pages 32, plates 12, figs. 4.

No. 154 — December.— Commercial fertilizers for potatoes. W. H. Jordan. Pages 12.

No. 155 — December.— Sugar beet investigation in 1898. L. L. Van Slyke. Pages 28.

No. 156 — December.— Spraying cucumbers in the season of 1898. F. A. Sirrine and F. C. Stewart. Pages 28, plates 5.

No. 157 — December.— Self-fertility of the grape. S. A. Beach. Pages 40, plates 5, figs. 3.

W. H. JORDAN, Director.

New York Agricultural Experiment Station,
Geneva, N. Y., Dec. 31, 1898.

NEWSPAPERS AND PERIODICALS PRESENTED TO THE STATION.

Acker & Gartenbau Zeitung, Milwaukee, Wis.

Agricultural Epitomist, Indianapolis, Ind.

Agricultural Gazette of New South Wales, Sydney, N. S. W.

Agricultural Student, Columbus, Ohio.

Agricultural Students' Gazette, Cirencester, Eng.

Albany Weekly Journal, Albany, N. Y.

Allegan Gazette, Allegan, Mich.

American Agriculturist, New York, N. Y.

American Cultivator, Boston, Mass.

American Grange Bulletin and Scientific Farmer, Cincinnati, Ohio.

American Philosophical Society, Proceedings, Philadelphia, Penn.

American Stock Keeper, Boston, Mass.

Angelica Every Week, Angelica, N. Y.

Baltimore Weekly Sun, Baltimore, Md.

Canadian Horticulturist, Toronto, Canada.

Chicago Dairy Produce, Chicago, Ill.

Church and Farm, Salt Lake City, Utah.

Cincinnati Society of Natural History, Journal, Cincinnati, Ohio.

Commercial Gazette, New York, N. Y.

Cotton Planters' Journal, Memphis, Tenn.

Dairy World, London,, Eng.

Detroit Free Press, Detroit, Mich.

DeRuyter Gleaner, DeRuyter, N. Y.

Elgin Dairy Report, Elgin, Ill.

Farm and Fireside, Philadelphia, Pa.

Farm and Home, Springfield, Mass.

Farm Journal, Philadelphia, Pa.

Farm Poultry Semi-Monthly, Boston, Mass.

Farm, Stock and Home, Minneapolis, Minn.

Farmers' Advocate, London, Canada.

Farmers' Guide, Huntington, Ind.

Farmers' Home, Dayton, Ohio.

Farmers' Magazine, Springfield, Ill.

Farmers' Voice, Chicago, Ill.

Geneva Gazette, Geneva, N. Y.

Gentleman Farmer, Chicago, Ill.

Gleanings in Bee Culture, Medina, Ohio.

Green's Fruit Grower, Rochester, N. Y.

Herd Register, Peterboro, N. H.

Hoard's Dairyman, Fort Atkinson, Wis.

Homestead, Des Moines, Iowa.

Horticultural Gleaner, Austin, Tex.

Indiana Farmer, Indianapolis, Ind.

Industrial American, Lexington, Ky.

Industrie Laitière, Paris, France.

Iowa Weather and Crop Service Review, Des Moines, Iowa.

Irrigation Age, Chicago, Ill.

Ithaca Democrat, Ithaca, N. Y.

Jersey Bulletin, Indianapolis, Ind.
Long Island Farmer, Jamaica, N. Y.
Louisiana Planter and Sugar Manufacturer, New Orleans, La.
Market Garden, Minneapolis, Minn.
Mirror and Farmer, Manchester, N. H.
Mohawk Valley Democrat, Fonda, N. Y.
Montana Fruit Grower, Missoula, Mont.
Monthly Weather Review, Washington, D. C.
National Nurseryman, Rochester, N. Y.
National Stockman and Farmer, Buffalo, N. Y.
Nebraska Farmer, Lincoln, Neb.
New England Farmer, Boston, Mass.
New England Florist, Boston, Mass.
New York Farm and Fireside, Springfield, Ill.
New York Farmer, Port Jervis, N. Y.
Northwest Pacific Farmer, Portland, Or.
Olean Herald, Olean, N. Y.
Oregon Agriculturist, Portland, Or.
Pacific Coast Dairyman, Tacoma, Wash.
Pomona Herald, Pascoag and Providence, R. I.
Practical Farmer, Philadelphia, Pa.
Prairie Farmer, Chicago, Ill.
Prattsburgh News, Prattsburgh, N. Y.
Queensland Agricultural Journal, Brisbane, Queensland.
Salt Lake Herald, Salt Lake City, Utah.
Sanitary Inspector, Augusta, Me.
Southern Planter, Richmond, Va.
Southern Farm Magazine, Baltimore, Md.
State Board of Health Bulletin, Memphis, Tenn.
Strawberry Specialist, Kittrell, N. C.
Suffolk Bulletin, Huntington, N. Y.
Sugar Beet, Philadelphia, Pa.
Texas Stockman and Farmer, San Antonio, Tex.
Vermont Farmers' Advocate, Burlington, Vt.

Wallace's Farmer, Des Moines, Iowa.
Watkins Review, Watkins, N. Y.
West Virginia Farm Reporter.
Western Fruit Grower, St. Joseph, Mo.
Western Plowman, Chicago, Ill.
Woman's Home Companion, Philadelphia, Pa.
Wool Record, New York, N. Y.

REPORT

OF THE

Department of Animal Husbandry.

W. H. Jordan, *Director.*

William P. Wheeler, *First Assistant.*

C. G. Jenter, *Assistant Chemist.*

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REPORT OF THE DEPARTMENT OF ANIMAL HUSBANDRY.

I. THE ECONOMY OF USING ANIMAL FOOD IN POULTRY FEEDING.*

W. P. Wheeler.

SUMMARY.

A ration in which about two-fifths of the protein was supplied by animal food was much more profitably fed to chicks than another ration supplying an equal amount of protein mostly from vegetable sources but supplemented by skim-milk curd.

When the two rations were fed to cockerels also, the results were favorable to the animal food, but the difference was not so pronounced as with the chicks.

Pullets fed the ration containing the large proportion of animal food attained ultimately somewhat the larger average size, but the chief advantage over those fed the vegetable ration was in the more rapid growth and earlier maturity.

With ducklings much the better results accompanied the feeding of a ration in which about half the protein was supplied by animal food. The growth was over three times as rapid as under another ration in which most of the protein was of vegetable origin with enough of skim-milk curd added to supply about one-fourth of the total protein.

In the general vigor and health of the birds there was some difference in favor of the animal food ration. This difference was very pronounced with the ducklings.

* Reprint of Bulletin No. 149.

INTRODUCTION.

One of the most important questions to consider in the feeding of poultry is the relative efficiency of the protein or nitrogenous matter in different foods and the economy of their use. While the several principal constituents of foods may all be sources of energy and of material for the large amount of fat stored in the egg and in the body, nothing except the protein, or several nitrogenous constituents, can supply the necessary nitrogen. Inasmuch as the more common and cheaper foods all contain heat and fat producing constituents in abundance, the source of the nitrogen naturally receives first consideration.

As a rule some forms of protein can be obtained at much less cost in grain foods and various by-products derived from grains and seeds than other forms of protein from animal foods. It is therefore of immediate practical importance to know whether the cheaper rations, consisting entirely or largely of vegetable foods, are efficient enough to be economical, or whether a large proportion of animal food is essential. The amount of protein that can be obtained by the common fowl from the coarser vegetable foods such as clover, is relatively small, although it is important to utilize these foods as far as possible.

The natural animal foods eaten by fowls contain usually a high percentage of nitrogenous matter and not a large proportion of fat. Many of the artificial foods, except such as dried blood and skim-milk, contain usually, besides the nitrogenous matter, a high percentage of fat, which often is not especially desired in compounding the ration. For instance, both earth worms and grasshoppers contain nearly ten times as much protein as fat, while ordinary fresh-cut bone contains about equal amounts of protein and fat.

CONDITIONS OF THE EXPERIMENT.

During two years a number of feeding experiments have been made in growing fowls on rations containing greater or less proportions of animal foods. Those experiments in which rations

consisting wholly of vegetable foods were used in contrast to those containing animal foods will be reported later. In the feeding experiment whose results are herein published, some skim-milk or curd was added to the rations which contained otherwise only vegetable food. This was to increase the palatability, to insure a fair proportion of nitrogen and to ascertain whether the moderate use of skim-milk curd would compensate for the lack of other animal food.

The animal food mostly used was the ground, dried "animal meal." This has generally proved more palatable than dried blood, and was found more convenient for daily use during warm weather than cut bone, which contained also a relatively larger percentage of fat.

Experiments made some years before (see Bulletin No. 39) had shown skim milk to be a profitable addition to ordinary rations while other experiments (see Bulletin No. 126) had shown no disadvantage in the use of ground grain instead of whole grain, and these facts were considered in arranging the ration.

In this experiment two lots of chicks were fed for about four and one-half months and two lots for four months. The pullets from the corresponding lots were fed together for a month and a half longer. Two lots of cockerels were fed for three months and two lots of ducklings for four months. About one-quarter of the chicks in each lot were Brahmas and Wyandottes and about three-quarters of them were Leghorns. The cockerels used were mostly Wyandottes with a few Brahmas and Cochins. The ducklings were Pekins. All the chicks and ducklings used were hatched in incubators and reared in outdoor brooders. They were allowed the run of small separate yards. The cockerels were removed when about twelve weeks old and the feeding continued with the pullets. Occasionally a chick escaped through the netting into outside flocks where it could not be identified and was dropped from the lot. The weight of any that died was counted as loss in live weight.

THE RATIONS.

One ration consisted of wheat, corn, animal meal, fresh bone and a grain mixture, "No. 1," composed of twelve parts by weight of corn meal, four parts wheat flour, two parts ground oats and one part each of wheat bran, wheat middlings, pea meal and old process linseed meal. One lot of chicks having this ration had also for the first few weeks a little oat meal and some skim milk and curd. The contrasted ration consisted of wheat, corn, skim milk or curd and a grain mixture "No. 2," composed of six parts pea meal, four parts old process linseed meal, two parts each of wheat bran, ground oats and high grade gluten meal, and one part each of wheat middlings and corn meal. One lot having this ration also had at the start a little oat meal. Another mixture, "No. 3," which it was necessary to substitute for "No. 2" mixture near the end of one feeding trial, consisted of two parts each of old process linseed meal, wheat bran, ground oats and gluten meal, and one part each of wheat middlings and corn meal. To about every 100 pounds of each grain mixture one ounce of salt was added. Green alfalfa was fed to each lot. The dry matter of the green food eaten by chicks has usually been so small in amount that its consideration did not affect the averages of total food for short periods. The cost also of the green food was so small as not to appear in average estimates but only in aggregates for the longer periods. For this reason account of the green food does not reguarly appear in all the tabulated data which follow.

VALUATION OF FOODS.

In estimating the cost of food, corn meal, wheat bran and wheat middlings were rated at $13.00 per ton, ground oats at $16.00, linseed meal at $20.00, coarse flour at $26.00, gluten meal at $23.00 and pea meal at $13.50 per ton. Wheat was rated at 80 cents per bushel and corn at 38 cents per bushel. Animal meal and dried blood were rated at $40.00 per ton, fresh bone at 80 cents per 100 pounds and green fodder at $2.00 per ton.

The grain mixtures and other foods averaged in composition as follows :

TABLE I.—COMPOSITION OF MATERIALS FED TO POULTRY.

FOOD.	Water.	Ash.	Protein.	Fibre.	Nitrogen free extract.	Fat.
	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
Grain mixture, No. 1...	12.3	2.0	11.7	2.9	67.9	3.2
Grain mixture, No. 2...	10.1	3.5	22.3	6.5	53.9	3.7
Grain mixture, No. 3...	12.9	3.2	16.4	6.1	58.4	3.0
Corn meal	13.3	1.2	9.6	1.6	70.6	3.7
Wheat bran	12.6	4.9	14.8	7.5	55.8	4.4
Ground oats	10.6	3.0	12.2	10.3	59.7	4.2
Oat meal (granulated)..	10.1	3.5	13.0	2.0	66.7	4.7
Cracked corn	13.5	1.1	9.4	1.3	71.5	3.2
Wheat	13.6	1.8	11.3	2.2	69.1	2.0
Animal meal	6.3	32.8	37.7	1.8	6.6	14.8
Dried blood	8.6	2.7	86.4	.4	1.5	.3
Curd	67.3	1.1	24.8	....	4.3	2.5
Skim-milk	90.5	.7	3.2	....	5.1	.5
Fresh bone	34.2	22.8	20.6	....	1.9	20.5
Alfalfa (green)	78.1	1.9	4.2	5.8	9.1	.9
Alfalfa hay	16.0	9.1	16.8	23.2	32.5	2.3

FIRST FEEDING TRIAL WITH CHICKS.

The feeding trial with the first two lots of chicks began when they were one-half week old and continued until the pullets were nearly full grown and some had commenced laying. The records of feeding and the results follow in tabulated form, averaged most of the time for periods of two weeks. As the chicks approached maturity and the growth was slow the feeding periods were longer. Lot I had the ration which contained animal meal and Lot II the contrasted ration. While about the same amount of protein was supplied per fowl in the two rations, that containing the animal meal had somewhat the wider nutritive ratio.

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TABLE II.— FOOD GIVEN AND GAIN PRODUCED BY CHICKS FED ANIMAL MEAL. (LOT I.)

Number of days in period.	Average age of chicks at beginning of period	Average weight of chicks at end of period.	Number of chicks.	Average per fowl during period. Mixed grain No. 1.	Wheat.	Cracked corn.	Oatmeal.	Animal meal.	Skim milk.	Total food per day.	Dry matter in food per day.	Protein in food per day.	Cost of food per day.	Approximate nutritive ratio.	Average gain in weight per chick during period.	Dry matter in food per day for each pound live weight.	Cost of food for each pound gain in weight.	Dry matter in food consumed for each pound gain in weight.
	Weeks	Lbs.		Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Cts.		Ozs.	Ozs.	Cts.	Lbs.
14	.5	.2	42	2.1	1.3	....	.6	.6	.6	.4	.3	.05	.02	1:4.9	1.8	1.8	2.7	2.2
14	2.5	.4	42	3.8	2.1	.7	.3	1.3	1.1	.7	.5	.09	.04	1:4.5	2.3	1.9	4.0	3.2
14	4.5	.7	41	7.7	4.3	1.0	....	2.1	Curd .4	1.1	1.0	.17	.08	1:4.6	5.2	1.9	3.3	2.6
14	6.5	1.1	41	11.5	5.6	4.3	....	4.2	1.1	1.9	1.6	.30	.14	1:4.4	6.2	1.9	4.8	3.7
14	8.5	1.5	39	15.1	5.0	2.9	....	4.2	1.0	2.0	1.7	.32	.14	1:4.5	5.9	1.4	5.3	4.2
14	10.5	2.1	37	17.2	7.3	2.7	....	6.4	....	2.4	2.1	.39	.17	1:4.3	9.2	1.2	4.1	3.2
14	12.5	2.7	26	20.0	7.4	5.5	....	7.6	....	2.9	2.6	.47	.19	1:4.4	7.0	1.1	6.2	5.1
14	14.5	3.1	22	16.1	12.2	8.8	....	6.7	....	3.1	2.8	.47	.21	1:4.8	6.6	1.0	7.2	5.9
14	16.5	3.9	22	14.8	11.1	9.8	Oats	7.7	....	3.1	2.7	.49	.21	1:4.6	13.1	.8	3.6	2.9
14	18.5	3.9	22	23.2	16.9	9.5	.7	9.1	....	4.3	3.7	.65	.29	1:4.8	.....	1.0	.....	.....
35	20.5	4.7	22	91.7	19.6	18.2	....	28.0	Fresh bone 3.5	4.6	4.1	.74	.30	1:4.4	13.4	.9	12.6	10.6
*14	....	3.9	28	23.5	13.3	6.4	....	6.6	....	3.6	3.1	.52	.24	1:5.0	4.6	.8	11.6	9.6
*28	....	4.2	24	51.2	35.3	18.5	....	10.4	.8	4.2	3.6	.56	.27	1:5.5	8.7	.9	11.1(?)	9.5(?)

* Some pullets from Lot I and some from Lot III fed together during these periods.

TABLE III.—FOOD GIVEN AND GAIN PRODUCED BY CHICKS FED VEGETABLE FOODS.

(LOT II.)

Number of days in period.	Average age of chicks at beginning of period.	Average weight of chicks at end of period.	Number of chicks.	Average per fowl during period. Mixed grain No. 2.	Wheat.	Cracked corn.	Oat meal.	Skim-milk.	Total food per day.	Dry matter in food per day.	Protein in food per day.	Cost of food per day.	Aproximate nutritive ratio.	Average gain in weight per chick during period.	Dry matter in food per day for each pound live weight fed.	Cost of food for each pound gain in weight.	Dry matter in food consumed for each pound gain in weight.
	Weeks.	Lbs.		Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Cts.		Ozs.	Ozs.	Cts.	Lbs.
14	.5	.2	42	2.2	.7	....	.04	.6	.3	.2	.04	.02	1:3.5	1.3	1.4	2.6	2.1
14	2.5	.3	42	3.1	2.2	....	.04	.7	.5	.4	.08	.03	1:4.5	1.8	1.8	3.7	3.2
								Curd									
14	4.5	.5	41	6.0	3.5	1.0	....	.4	.8	.7	.14	.05	1:4.0	2.8	1.8	3.9	3.4
14	6.5	.8	41	8.3	5.5	5.3	....	2.0	1.5	1.2	.25	.10	1:4.2	4.5	2.0	4.8	3.9
14	8.5	1.0	39	10.4	4.9	3.8	....	4.5	1.7	1.3	.31	.12	1:3.3	4.0	1.5	7.0	4.6
14	10.5	1.3	39	10.6	7.6	2.0	....	4.6	1.8	1.4	.33	.14	1:3.3	4.9	1.2	6.3	4.0
14	12.5	1.6	27	13.9	7.0	4.3	....	6.0	2.2	1.7	.41	.17	1:3.3	3.2	1.2	11.7	7.6
14	14.5	1.9	22	12.9	9.0	14.7	....	4.6	2.9	2.4	.46	.19	1:4.4	4.2	1.4	10.2	8.1
14	16.5	2.0	22	8.7	10.9	5.3	....	8.4	2.4	1.8	.41	.20	1:3.4	2.7	.9	16.6	9.1
14	18.5	2.4	22	19.7	13.4	6.3	....	7.6	3.4	2.7	.60	.25	1:3.5	6.0	1.2	9.1	6.2
35	20.5	3.2	22	73.8	19.3	21.4	....	12.6	3.6	3.0	.59	.23	1:4.1	13.0	1.1	9.9	8.1
*14	....	3.1	28	20.4	18.3	7.4	....	2.8	3.5	2.9	.49	.23	1:5.1	3.8	1.0	13.8	10.9
*28	....	3.7	24	38.1	34.4	16.5	....	16.5	3.8	3.0	.56	.28	1:4.3	9.7	.9	13.0	8.5

* Some pullets from Lot II and some from Lot IV fed together during these periods.

RELATIVE EFFICIENCY OF THF RATIONS.

More food was at all times eaten by the chicks having the animal meal ration. During the first twelve weeks the dry matter in the food consumed by Lot I was 36 per cent greater than in that consumed by Lot II and the gain in weight was 56 per cent greater. Lot I gained one pound in weight for every 3.3 lbs. of water-free food and Lot II gained one pound for every 3.8 lbs. of water-free food.

During the next eight weeks after the cockerels were removed the dry matter in the food was nearly 37 per cent the greater for Lot I and the gain in weight was 66 per cent greater than that of Lot II. One pound gain was made by Lot I for every 6.1 lbs. of water-free food and one pound gain by Lot II for every 7.5 lbs. of water-free food.

The next five weeks showed the same relative consumption of food, although growth was much slower and about the same for each lot, slightly favoring Lot I. The dry matter in the food for Lot I was about 36 per cent more than for Lot II. One pound gain was made for every 10.6 lbs. of water free food by Lot I and one pound gain for every 8.1 lbs. of water free food by Lot II.

For the last six weeks the food consumption was nearly 18 per cent greater for Lot I. The gain in weight was almost identical for both lots, but three pullets began laying in Lot I nearly a month before any commenced to lay in Lot II.

RELATIVE ECONOMY OF THE RATIONS.

The cost of food per pound gain in weight during the first twelve weeks was 4.25 cents for Lot I and 5.19 cents for Lot II, an excess of 22 per cent. During the next eight weeks the cost was about 50 per cent greater for Lot II, the cost per pound of gain being 7.5 cents and 11.2 cents, respectively. After this when the growth was much slower the food cost of the gain made was much greater for both lots. The difference was in favor of Lot II for

five weeks, and afterward was again in favor of Lot I, especially when allowance was made for the weight of the few eggs laid.

At twelve weeks of age the average weight for the chicks in Lot I was 2 lbs. and for those in Lot II about 1.3 lbs. The average weight of one-half pound was reached by Lot I over a week sooner than by Lot II, the average weight of 1 lb. two and one-half weeks sooner, the average weight of 1.5 lbs. three and one-half weeks sooner, the average weight of 2 lbs. over five weeks sooner. The average weight of 3 lbs. was attained over eight weeks sooner by Lot I than by Lot II.

SECOND FEEDING TRIAL WITH CHICKS.

The feeding trial with the chicks of Lots III and IV began when they were six weeks old and was continued for fourteen weeks, the pullets from Lot III being afterward included in Lot I and those from Lot IV in Lot II. Some of the chicks from each lot were also fed the contrasted rations for three weeks before the main trial began. The records for this time precede in the following tables those for the main trial, which latter are averaged for periods of two weeks each. The rations were similar to those fed to Lots I and II. Lot III had the ration containing animal meal.

As with the first two lots more food was eaten under the ration containing the most animal food. The nutritive ratio of this ration was somewhat the wider, although the amount of protein supplied per fowl was about the same under both rations.

TABLE IV.—FOOD GIVEN AND GAIN PRODUCED BY CHICKS FED ANIMAL MEAL.

(LOT III.)

Number of days in period.	Average age of chicks at beginning of period.	Average weight of chicks at end of period.	Number of chicks.	Average per fowl during period. Mixed grain No. 1.	Wheat.	Cracked corn.	Animal meal.	Fresh bone.	Total food per day.	Dry matter in food per day.	Protein in food per day.	Cost of food per day.	Approximate nutritive ratio.	Average gain in weight per chick during period.	Dry matter in food per day for each pound live weight fed.	Cost of food for each pound gain in weight.	Dry matter in food consumed for each pound gain in weight.
	Weeks.	Lbs.		Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Cts.		Ozs.	Ozs.	Cts.	Lbs.
21	3	.6	12	9.2	6.7	4.6	1.9	....	1.1	.9	.14	.07	1:5.6	5.5	2.0	4.1	3.6
14	6	.8	33	8.5	3.9	1.4	2.1	....	1.1	1.0	.17	.07	1:4.9	5.6	1.6	3.0	2.5
14	8	1.1	33	13.3	6.4	3.5	3.9	....	1.9	1.7	.29	.13	1:4.8	4.0	1.8	7.2	6.0
14	10	1.5	33	11.2	4.8	4.3	5.0	....	1.8	1.6	.30	.12	1:4.3	6.1	1.3	4.5	3.8
14	12	1.8	32	13.2	7.8	4.6	4.3	....	2.1	1.9	.32	.14	1:4.8	5.4	1.2	6.0	4.9
14	14	2.5	32	22.3	6.2	4.1	7.4	....	2.9	2.5	.46	.19	1:4.4	11.6	1.2	3.7	3.0
14	16	2.7	32	19.0	7.3	4.1	8.4	.8	2.8	2.5	.48	.20	1:4.1	3.7	1.2	12.0	9.4
14	18	3.1	32	24.4	7.1	4.3	7.4	1.0	3.2	2.8	.51	.21	1:4.5	5.9	1.0	8.0	6.7

TABLE V.—FOOD GIVEN AND GAIN PRODUCED BY CHICKS FED VEGETABLE FOODS.

(LOT IV.)

Number of days in period.	Average age of chicks at beginning of period.	Average weight of chicks at end of period.	Number of chicks.	Average per fowl during period. Mixed grain No. 2.	Wheat.	Cracked corn.	Curd.	Total food per day.	Dry matter in food per day.	Protein in food per day.	Cost of food per day.	Approximate nutritive ratio.	Average gain in weight per chick during period.	Dry matter in food per day for each pound live weight fed.	Cost of food for each pound gain in weight.	Dry matter in food consumed for each pound gain in weight
	Weeks.	Lbs.		Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Cts.		Ozs.	Ozs.	Cts.	Lbs.
21	3	.6	12	6.7	7.1	4.4	2.3	1.0	.8	.16	.07	1:4.2	4.9	1.9	4.7	3.4
14	6	.7	33	7.0	3.4	2.4	2.5	1.1	.9	.20	.07	1:3.4	3.0	1.5	5.8	4.0
14	8	.7	33	7.1	4.1	3.8	3.4	1.3	1.0	.23	.10	1:3.5	1.4	1.5	15.9	10.5
14	10	.9	32	6.7	3.6	3.9	2.8	1.2	1.0	.21	.09	1:3.6	1.9	1.2	10.3	7.2
14	12	1.1	31	9.2	8.4	4.9	4.3	1.9	1.5	.33	.14	1:3.8	2.6	1.5	12.0	8.1
14	14	1.5	30	15.8	6.4	5.7	4.8	2.3	1.9	.43	.16	1:3.5	6.9	1.4	5.2	3.8
14	16	1.8	30	17.6	5.9	5.2	4.2	2.4	1.9	.44	.16	1:3.5	3.7	1.2	9.4	7.2
14	18	2.4	30	21.7	6.6	9.1	4.5	3.0	2.5	.52	.19	1:3.8	9.2	1.2	4.7	3.7

RELATIVE EFFICIENCY AND ECONOMY OF THE RATIONS.

In the food eaten by Lot III there was about 37 per cent more dry matter than in that eaten by Lot IV and the gain in weight was about 54 per cent greater. One pound gain was made by Lot III for every 4.6 lbs. water-free food and one pound gain by Lot IV for every 5.2 lbs. of water-free food. The food cost of growth was nearly 27 per cent greater for Lot IV, the cost of food per pound gain in weight during the fourteen weeks being 5.6 cents for Lot III and 7.1 cents for Lot IV.

During the preliminary period of three weeks with part of the chicks, those having the animal meal ration gained 13.5 per cent more in weight and consumed 17 per cent more food. The water-free food required was 3.6 lbs. by Lot III for each pound gain in weight and 3.4 lbs. by Lot IV. The food cost per pound gain was about 4.1 cents for Lot III and about 4.7 cents for Lot IV.

The average weight of 1 lb. was reached by Lot III three and one-half weeks sooner than by Lot IV and the average weight of 2 lbs. over four weeks sooner. When the chicks in Lot III had attained the average weight of 3 lbs. those in Lot IV averaged less than 2.2 lbs.

THE FEEDING TRIAL WITH COCKERELS.

The feeding trial with the two lots of cockerels began in September when they were about three months old. The two lots were alike at the start and averaged almost exactly the same in weight. As in the other feeding trials the amount of protein supplied per fowl was about the same for the two lots, but the nutritive ratio was somewhat wider with the animal meal ration.

TABLE VI.—FOOD GIVEN AND GAIN PRODUCED BY COCKERELS FED ANIMAL MEAL.

(LOT A.)

Number of days in period.	Average weight per fowl at end of period.	Number of fowls.	Average per fowl during period. Mixed grain No. 1.	Wheat.	Cracked corn.	Animal meal.	Fresh bone.	Alfalfa.	Total food per day.	Dry matter in food per day.	Protein in food per day.	Cost of food per day.	Approximate nutritive ratio.	Average gain in weight per fowl during period.	Dry matter in food per day for each pound live weight fed.	Cost of food for each pound gain in weight.	Dry matter in food consumed for each pound gain in weight.
	Lbs.		Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Cts.		Ozs.	Ozs.	Cts.	Lbs.
14	4.7	19	39.9	15.8	8.8	9.4	....	23.5	7.0	5.0	.84	.35	1:4.9	11.8	1.2	6.5	5.9
14	5.1	19	49.1	16.0	8.1	15.1	1.4	23.5	8.1	6.0	1.09	.43	1:4.4	6.9	1.2	13.9	12.2
14	5.6	18	50.3	10.9	8.8	15.5	1.8	24.9	8.0	5.9	1.09	.42	1:4.4	5.3	1.1	....	....
14	6.6	18	47.7	14.8	7.3	16.9	1.8	24.9	8.1	6.0	1.13	.44	1:4.2	16.4	1.0	6.4	5.4
								Hay.									
28	7.4	18	86.0	45.9	19.9	21.8	.8	24.9	7.1	6.2	1.06	.44	1:4.8	12.8	.9	15.3	13.6
								Green.									
56	6.6	...	184.2	57.7	33.0	56.6	5.0	96.9	7.7	5.7	1.03	.41	1:4.5	39.5	1.1	9.3	8.0

The lower line gives the condensed data for the first eight weeks above.

TABLE VII.—FOOD GIVEN AND GAIN PRODUCED BY COCKERELS FED VEGETABLE FOODS.

(LOT B.)

Number of days in period.	Average weight per fowl at end of period.	Number of fowls.	Average per fowl during period. Mixed grain No. 2.	Wheat.	Cracked corn.	Curd.	Alfalfa.	Total food per day.	Dry matter in food per day.	Protein in food per day.	Cost of food per day.	Approximate nutritive ratio.	Average gain in weight per fowl during period.	Dry matter in food per day for each pound live weight fed.	Cost of food for each pound gain in weight.	Dry matter in food consumed for each pound gain in weight.
	Lbs.		Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Cts.		Ozs.	Ozs.	Cts.	Lbs.
14	4.0	19	22.3	9.0	11.1	12.0	23.5	5.6	3.3	.78	.30	1:3.3	1.9	.8	....	....
14	4.4	19	39.1	12.0	12.7	9.1	23.5	6.9	4.6	1.04	.35	1:3.5	6.4	1.1	13.3	10.1
14	4.9	18	39.8	24.6	9.7	6.4	24.9	7.5	5.2	1.09	.39	1:3.9	6.2	1.1	14.1	11.7
14	5.8	18	42.8	12.5	10.5	6.3	24.9	6.9	4.6	.86	.34	1:4.4	14.0	.9	5.4	4.6
							Hay.									
28	6.7	18	70.8	45.4	9.5	16.0	24.9	6.0	4.8	.92	.40	1:4.2	16.0	.8	11.6	8.7
							Green.									
56	5.8	....	143.9	57.7	44.2	34.2	96.6	6.7	4.4	.94	.35	1:3.8	28.2	.9	11.0	8.8

The lower line gives the condensed data for the first eight weeks above.

The gain in weight was not very regular nor very great for either lot, although for short periods some rapid gains were made. Those birds (Lot A) having the animal meal ration gained in weight during the trial about 20 per cent more than the others.

During the first eight weeks the consumption of food by Lot A was about 28 per cent greater than that of Lot B and the gain in weight was about 40 per cent greater. One pound gain in weight was made by Lot A for every 8 lbs. of water-free food consumed and one pound gain by Lot B for every 8.8 lbs. of water-free food. During the last four weeks more food was still eaten by Lot A, but the gain made was considerably in favor of Lot B as well as the cost of the gain. The gain in weight for this period, however, was not economically made by either lot.

FEEDING TRIAL WITH DUCKLINGS.

The feeding trial with the two lots of ducklings began as soon as they had learned to eat and was continued until growth had become very slow. The ration for Lot A, beside the grain mixture No. described on page 48, consisted of corn meal, ground oats and animal meal besides a little skim milk, curd and dried blood. Lot B, besides the mixed grain No. 2, was fed wheat bran, corn meal, ground oats and skim milk or milk curd. Both lots were fed green alfalfa from the start. Sand and coarse grit were freely supplied. The ration containing the animal meal had generally somewhat the wider nutritive ratio and for the same live weight fed supplied much less protein, although on account of the much greater consumption of food the amount of protein per fowl was considerably larger under this ration.

The data follow in tabulated form, averaged in periods of one week during the time of most rapid growth.

TABLE VIII.—FOOD GIVEN AND GAIN PRODUCED BY DUCKLINGS FED ANIMAL MEAL.

(LOT A.)

Number of days in period.	Age of ducklings at beginning of period.	Average weight per fowl at end of period.	Number of fowls.	Average per fowl during period. Mixed grain No. 1	Ground oats.	Corn meal.	Animal meal.	Dried blood.	Skim milk.	Alfalfa.	Total food per day.	Dry matter in food per day.	Protein in food per day.	Cost of food per day.	Approximate nutritive ratio.	Average gain in weight per fowl during period.	Dry matter in food per day for each pound live weight fed.	Cost of food for each pound gain in weight.	Dry matter in food consumed for each pound gain in weight.
	Weeks.	Lbs.		Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Cts.		Ozs.	Ozs.	Cts.	Lbs.
5	.1	.2	32	.6	....	.1	.1	...	.4	....	.2	.1	.02	.00	1:4.2	.6	.8	1.6	1.0
7	.9	.3	32	2.6	.6	1.5	.6	...	1.3	....	.9	.7	.11	.05	1:5.1	1.6	2.8	2.6	2.5
7	1.9	.4	32	4.7	.2	1.9	4.2	...	....	....	1.6	1.4	.33	.12	1:3.1	2.3	4.0	5.8	4.3
7	2.9	.9	32	10.9	1.8	3.3	3.1	...	Curd. .5	.7	2.8	2.4	.44	.15	1:4.5	8.1	3.7	2.4	2.1
7	3.9	1.5	32	11.5	1.3	6.3	4.2	...	....	.7	3.3	3.0	.53	.20	1:4.6	9.0	2.5	2.5	2.3
7	4.9	2.2	32	22.0	2.7	4.5	6.3	...	1.7	1.0	5.3	5.6	.88	.35	1:4.2	11.5	2.5	3.4	2.8
7	5.9	3.1	32	25.8	1.3	1.5	8.2	...	2.1	1.0	5.6	4.8	.99	.39	1:3.8	13.9	1.8	3.2	2.4
7	6.9	3.5	32	23.9	1.9	.8	6.0	1.5	....	2.0	5.2	4.4	.96	.32	1:3.5	5.8	1.3	6.2	5.3
7	7.9	4.4	32	29.0	.6	2.5	6.5	.4	.8	10.5	7.2	5.3	1.00	.37	1:4.3	14.6	1.3	2.9	2.5
7	8.9	4.8	32	36.3	.3	2.7	10.6	.3	....	10.5	8.7	6.7	1.33	.48	1:4.0	6.9	1.5	7.7	6.8
35	9.9	5.6	32	125.1	4.1	11.1	51.4	.9	....	52.5	7.0	5.1	1.10	.39	1:3.6	14.8	1.0	14.1	12.4

TABLE IX.—FOOD GIVEN AND GAIN PRODUCED BY DUCKLINGS FED VEGETABLE FOOD. (LOT B.)

Number of days in period.	Age of ducklings at beginning of period.	Average weight per fowl at end of period.	Number of fowls.	Average per fowl during period. Mixed grain No. 2.	Wheat bran.	Corn meal.	Ground oats.	Skim milk	Alfalfa.	Total food per day.	Dry matter in food per day.	Pro'ein in food per day.	Cost of food per day	Approximate nutritive ratio.	Average gain in weight per fowl during period.	Dry matter in food per day for each pound live weight fed.	Cost of food for each pound gain in weight.	Dry matter in food consumed for each pound gain in weight.
	Weeks.	Lbs.		Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Cts.		Ozs.	Ozs.	Cts.	Lbs.
5	.1	.15	33	.4	....	.1	....	1.0	....	.2	.1	.02	.01	1:3.8	.5	.8	.8	.9
7	.9	.2	33	.3	....	1.5	.6	1.3	....	.4	.3	.05	.02	1:5.8	.8	1.7	2.7	2.7
7	1.9	.2	32	2.0	....	4.5	.7	....	....	1.0	.9	.14	.05	1:5.8	.1	4.6	....	....
								Curd.										
7	2.9	.4	29	3.5	....	4.0	1.1	.6	.7	1.3	1.1	.20	.07	1:4.5	2.2	3.7	3.4	3.5
7	3.9	.5	28	2.7	1.0	1.9	1.0	....	.7	.9	.8	.15	.04	1:4.7	1.8	1.8	2.5	3.1
7	4.9	.7	28	7.1	1.8	1.7	1.0	3.2	1.2	2.1	1.6	.42	.14	1:2.9	2.9	2.7	5.5	3.9
7	5.9	.9	27	9.2	2.3	.8	1.1	5.5	1.2	2.7	2.0	.57	.20	1:2.6	4.4	2.5	5.2	3.1
7	6.9	1.2	27	10.1	4.3	2.8	1.8	9.8	2.4	4.5	2.9	.81	.34	1:2.7	4.4	2.8	8.6	4.7
7	7.9	1.5	27	9.1	2.6	.8	1.2	6.9	12.5	4.7	2.4	.70	.25	1:2.6	4.0	1.8	7.0	4.3
7	8.9	1.5	27	17.1	4.4	2.8	....	5.9	12.5	6.1	3.8	.96	.30	1:3.0	.5	2.5	....	....
35	9.9	3.0	21	81.4	21.5	8.9	7.5	38.8	79.2	6.8	3.9	1.03	.34	1:2.8	19.7	1.7	9.7	6.9
				No.1.														
28	14.9	5.0	20	133.2	....	8.7	4.7	....	67.2	9.2	6.6	1.31	.47	1:4.0	32.4	1.6	6.5	5.7

RELATIVE EFFICIENCY AND ECONOMY OF THE RATIONS.

From the first the ration containing the large proportion of animal food gave much the better results, although during the first week not so much difference was manifest. The grain mixture No. 2, of the contrasted ration, appeared to be much less palatable to the ducklings than to the chicks, and to lessen this disadvantage corn meal was quite freely used at the beginning with the skim milk and curd.

During the first ten weeks two and one-third times as much food was eaten by Lot A as by Lot B and the total increase in live weight was about four times as great. One pound gain was made by Lot A for every 3.1 lbs. of water-free food consumed and one pound gain by Lot B for every 5.2 lbs. of water-free food. The cost of food for each pound gain was about 3.7 cents for Lot A and 7.2 cents for Lot B, a difference not far from 95 per cent in favor of Lot A. The use of the animal meal increased the cost of the one ration, for while it constituted less than one-fifth the cost of total food beside the alfalfa it represented considerably over one-third of the total cost of the ration.

While the ducklings in Lot A were thrifty from the start, at all times free from disease and made an even flock, those in Lot B made an uneven growth and several died. The unevenness of size in the flock was very noticeable. At ten weeks of age the birds in Lot A seemed to have reached the limit of most profitable growth, for during the next five weeks the growth was slow and growth at the same rate could not generally show a profit over the cost of food. The dry matter in the food eaten was about one ounce per day for each pound live weight fed, a much lower rate than before. The dry matter in the food eaten by Lot B during this time was 1.67 ozs. per pound live weight fed, although the amount per fowl was, as before, less than for Lot A. The gain in weight made by Lot B was somewhat the greater and was made at less cost for food.

The slow growth made by Lot B for so long a time (during 15 weeks) did not prevent a more rapid gain being made when the ration was more favorable. This is shown by the results of feed-

ing Lot B for four weeks on the animal meal ration after the contrasted feeding was finished. The growth made by this lot was then rapid and the gain in weight nearly as great as that which had been made by Lot A two months earlier when the average size was about the same as that of the older birds from Lot B during this later period. The disadvantage of living on the inferior ration was, however, never entirely overcome, and the birds failed to reach the size ultimately attained by the birds having from the start the animal meal ration.

The average weight of 1 lb. was reached by Lot A three weeks sooner than by Lot B, the average weight of 2 lbs. over five weeks sooner and the average weight of 3 lbs. over eight weeks sooner. At seven weeks of age the average weight for Lot A was over 3 lbs. and for Lot B less than 1 lb. At nine weeks of age the average weight for Lot A was about 4.5 lbs. and for Lot B about 1.5. At eleven weeks of age the average weight for Lot A was 5 lbs. and for Lot B it was 2 lbs.

IN CONCLUSION.

The rations in which from 40 to 50 per cent of the protein was supplied by animal food gave in every trial more economical results than the contrasted rations in which most of the protein came from vegetable sources.

The chief advantage of the one ration over the other was in the much more rapid growth induced by it, although the cost for each pound gain in weight was also in its favor. The inefficiency of the one ration was probably in part due to its inferior palatability. This was not very noticeable with the chicks or cockerels, but it was quite apparent with the ducklings, especially at the start when slight modifications in the ration were continually made.

The results of this feeding experiment do not alone warrant final conclusions as to the necessity for animal food. But considering with them the results of other feeding experiments not yet reported, which all point in the same direction, there appears justification for the belief that the superiority of the one ration was due to the presence in it of the animal food.

REPORT

OF THE

Botanical Department.

F. C. STEWART, *Botanist.*

TABLE OF CONTENTS.

REPORT OF THE BOTANIST.

SPRAYING CUCUMBERS IN THE SEASON OF 1898.*

F. A. Sirrine and F. C. Stewart.

SUMMARY.

Downy mildew is the chief cause of the recent poor crops of late cucumbers in southeastern New York. Anthracnose has also been destructive in some seasons.

In 1896 the Station made an experiment which showed that the greater part of the damage from downy mildew can be prevented by spraying seven times with Bordeaux mixture.

An experiment made in 1897 showed that when an entire field is sprayed the downy mildew can be wholly prevented. In this experiment a yield of 101,960 merchantable pickles per acre was obtained.

In a second experiment in 1897, on early cucumbers, the yield was increased at the rate of 30,450 fruits per acre, having a weight of 12,405 pounds.

During the season of 1898 coöperative spraying experiments on late cucumbers were conducted in four different localities on Long Island; viz.: at Greenlawn, Deer Park, Smithtown Branch and Mattituck. In each case an entire field was sprayed. At Greenlawn the sprayed field contained 1.5 acres sprayed seven times with Bordeaux mixture (1-to-8 formula); at Deer Park, 2 acres sprayed eight times; at Smithtown Branch, 2.15 acres sprayed seven times; and at Mattituck, 2 acres sprayed five times.

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* Reprint of Bulletin No. 156.

Owing to late planting and lack of fertility the crop at Mattituck was a failure. At the other three places the yields of the sprayed fields over unsprayed fields in the same localities were as follows: At Greenlawn, 80,917 per acre; at Deer Park, 40,675; and at Smithtown Branch, 43,226. At Greenlawn the total yield of merchantable pickles per acre was 120,917.

The cost of spraying per acre for each application was as follows: At Greenlawn, $3.39; Deer Park, $2.76; Mattituck, $3.20; and Smithtown Branch, $2.43.

The value per acre of the increased yield above the cost of spraying was as follows: At Greenlawn, $73.74; Deer Park, $22.51; Smithtown Branch, $37.00.

The crop on these three experiment fields was profitable; that is, after deducting the total cost of growing, gathering and spraying from the value of the crop there was left, in each case, a net profit. At Greenlawn the net profit was $67.13 per acre; at Deer Park, $13.35 per acre; and at Smithtown Branch, $6.74 per acre.

At $1.25 per thousand, pickles can probably be profitably grown on Long Island if spraying is practiced and the crop given proper care.

In practice, the cost of spraying can be made considerably smaller than it was in these experiments — it can probably be reduced one-half.

According to our estimate, the average yield of unsprayed fields of late cucumbers on Long Island in 1898 did not exceed 34,000 per acre.

On Long Island, cucumbers should be sprayed as follows: Commencing some time between July 15 and August 1, spray thoroughly with Bordeaux mixture (1-to-8 formula) once every eight or ten days until frost.

INTRODUCTION.

During the past six or seven years late cucumbers in southeastern New York have suffered severely from disease. On Long Island and in Westchester County where cucumbers are grown extensively for pickling the losses from "blight" have been so

PLATE XIII.—THE OUTFIT USED AT DEER PARK.

great as to cause many growers to abandon the crop. Anthracnose and the bacterial or wilt disease have been responsible for a part of the damage, but the greater part of it has been caused by the downy mildew, *Plasmopara cubensis* (B. & C.) Humph. The latter fungus made its first appearance[1] in the United States in 1889, since which time it has spread so rapidly that it has become one of the most destructive diseases of late cucumbers. It now occurs quite generally throughout the northeastern United States as far west as Ohio, where it has been very destructive,[2] and appears to be spreading westward. No special effort has been made to determine its distribution in New York, but reports indicate that it is in nearly all parts of the State, although there are still a few localities where it is unknown. Besides the previously mentioned localities in southeastern New York we have, during the past season, personally observed it at Albany and Geneva, where it was destructive. There are no indications of its abatement; on the contrary, it seems to be steadily advancing. In localities where it has previously occurred it may be expected to reappear to a destructive extent the coming season, and localities in which it has not yet occurred cannot reasonably expect to remain much longer exempt from its ravages. However, the amount of damage which it does depends very largely upon the temperature between July 15 and August 15. A high temperature and frequent light rains during this period furnish ideal conditions for the propagation of the fungus.

PREVIOUS EXPERIMENTS.

In 1896.—In 1896 the Station made an experiment[3] in which it was shown that this downy mildew can be prevented by spraying the plants with Bordeaux mixture.

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[1] Halsted, B. D. Some Notes upon Economic Peronosporeæ for 1889, in New Jersey. Journal of Mycology, 5: 201.

[2] Selby, A. D. Prevalent Diseases of Cucumbers, Melons and Tomatoes. Ohio Agr. Exp. Sta. Bul. 89. D. 1897.

[3] The details of this experiment are reported in Bulletin 119. The Downy Mildew of the Cucumber: What It Is and How to Prevent It.

A field of late cucumbers containing one and three-fourths acres was divided into five plats, three of which were sprayed and the other two unsprayed, the sprayed plats alternating with the unsprayed. Spraying was commenced when the plants were quite small and repeated at intervals of from six to eleven days until frost. In all, seven applications were made.

The plants on the unsprayed plats were so violently attacked by downy mildew that they ceased to produce any merchantable fruit after August 21. The sprayed plants produced, after this date, cucumbers which were sold for $260, which is at the rate of $173 per acre. There was, however, toward the close of the season, considerable disease on the sprayed plats, enough to materially reduce the yield. This was due to the proximity of the diseased plants on the unsprayed plats. It was believed that if no unsprayed plants had been left to furnish a breeding place for the fungus the sprayed plants might have been kept practically free from disease up to the close of the season.

In 1897.— In order to determine what may be accomplished when no unsprayed plants are left, another spraying experiment[4] on late cucumbers was made in 1897.

An exact acre of late cucumbers was sprayed eight times. There were no unsprayed plants in the immediate vicinity, the nearest source of infection being an unsprayed muskmelon patch about thirty rods distant. When frost came the plants were entirely free from downy mildew and anthracnose, although both of these diseases were abundant in most of the cucumber fields in the vicinity. The acre yielded 101,960 merchantable cucumbers while the average yield of unsprayed fields was probably less than 20,000 per acre.

A second experiment[5] was made in 1897. Two hundred hills were planted in May. One-half of these were thoroughly sprayed throughout the season — in all, fourteen times. The other half were not sprayed.

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[4] Reported in Bul. 138: 641–643.

[5] Reported in Bul. 138: 636–639.

PLATE XIV.—THE OUTFIT USED AT GREENLAWN.

The yield[6] per acre for the sprayed plants was at the rate of 71,000 fruits, weighing 25,265 pounds; for the unsprayed plants at the rate of 40,650 fruits, weighing 12,860 pounds. Hence, the increase in the number of fruits per acre due to spraying was 30,450 and the increase in weight 12,405 pounds. The sprayed plants suffered considerably from anthracnose, but not at all from downy mildew.

EXPERIMENTS IN 1898.

INTRODUCTORY.

During the season of 1898 coöperative spraying experiments on late cucumbers were conducted in four different localities on Long Island; viz.: at Greenlawn, Deer Park, Mattituck and Smithtown Branch. In each case an entire field was sprayed. At Greenlawn the sprayed field contained one and one-half acres, sprayed seven times; at Deer Park, two acres, sprayed eight times; at Mattituck, two acres, sprayed five times; and at Smithtown Branch, 2.15 acres, sprayed seven times.

THE TERMS OF COÖPERATION.

The Station bore all expense of spraying and directed how and when it should be done. The owners of the fields experimented upon performed all of the operations connected with growing, gathering and marketing the crop according to their own judgment and at their own expense, and carried out the spraying under the direction of a representative of the Station.

Therefore, the Station is responsible for the spraying only, and does not commit itself to the recommendation of any of the cultural methods employed on these experiment fields.

THE SPRAYING OUTFIT.

The spraying outfit used consisted essentially of a two wheeled cart which carried a spray pump mounted in a 50-gallon barrel and fitted with two leads of hose twenty feet long. Three men

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6 These yields are not comparable with the yields in the preceding experiment because the fruits were allowed to attain greater size.

were required to operate the outfit, one to drive and pump and the two others to manage the nozzles. An idea of the general style of the outfit may be obtained from Plates XIII and XIV.

The outfits used at the different places differed only in the character of the cart. The pump, barrel and fittings were the same in each case and cost $27.46. The items are as follows:

1 "Eclipse" spray pump[7]	$10 00
40 ft. "Maltese Cross" hose	10 00
2 stop-cocks	1 50
Freightage on spray pump	65
4 nozzles	2 40
1 barrel	65
4.5 ft. brass tubing	56
3 strap-irons and bolts	45
Lumber	50
Labor	75
Total	$27 46

The pump was fastened into the barrel by means of a detachable head[8] which was secured to the barrel by three strap-bolts. This method of attaching the pump has been found not only more convenient but stronger than simply fastening it to the head which comes with the barrel.

The hose used was what is known to the trade as "Maltese Cross," warranted not to rot and to stand a pressure of 600 pounds of steam to the square inch. A three foot one-fourth inch brass tube, furnished with a stop cock and bent at one end was used to connect the same with the nozzles.

At the end of each lead of hose a single nozzle was used in the first two sprayings, but when the vines covered the ground two nozzles were used. The two nozzles were attached to the three foot brass tube by means of a short brass T. The bend in the three foot tube was made at an angle of from 35 to 40 degrees. Each arm of the T was about nine inches long and bent at about the same angle as the main tube, the object being to bring the

[7] Manufactured by Morrill & Morley, Benton Harbor, Mich.

[8] Described and illustrated by W. P[addock]. Rural New Yorker, 57: 29. 23 Apr., 1898.

PLATE XV.—THE SPRAYED FIELD AT GREENLAWN. PHOTOGRAPHED SEPT. 13.

orifices of the two nozzles about eighteen inches apart. "Deming Vermorel" nozzles were used and found very satisfactory for such work.

The twenty feet of heavy half-inch hose was somewhat unwieldy and awkward to handle. In fact, it was impossible to prevent dragging the vines unless the workman took a half twist of the hose around his body and over his shoulder. Hence we would recommend the use of a lighter hose because it would be more easily handled and also cheaper.

THE EXPERIMENT AT GREENLAWN.

(1) *Preparation and planting.*— The field, which contained one and one-half acres, scant, was plowed twice about six inches deep, after which one-half ton of "Great Eastern" fertilizer was applied broadcast and the field harrowed. The seed (Early Cluster) was planted June 20 in raised hills four feet apart each way. Eight loads[9] of well rotted stable manure were applied in the hills.

(2) *Cultivation and spraying.*— The field was cultivated twice each way with an ordinary moldboard plow, a hoe being used around the hills. The vines were sprayed seven times with Bordeaux mixture[10] as follows: July 20 and 30; August 9, 18 and 21; and September 2 and 13.

(3) *Yield and value of the crop.*—The first picking was made August 6. The total yield of first class pickles[11] from the one and one-half acres was 179,375, or 119,583 per acre; there were also sold from the field 2,000 nubs[12] which brings the total yield[13] of merchantable pickles up to 120,917 per acre.

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9 A load is usually estimated as a ton.

10 In all of the experiments in 1898 the Bordeaux mixture was made according to the 1-to-8 formula.

11 The small cucumbers used for pickling are universally called "pickles."

12 Deformed fruits are called "nubs" or "crooks."

13 There were thrown away 9,000 culls and it was estimated that 21,000 nubs and spoiled pickles were left on the field. The excessively hot weather at the close of August caused pickles to turn yellow very rapidly. Such pickles were pulled from the vines and left on the field. Dry weather in September favored the growth of nubs.

Of the first class pickles, 13,400 were sold at $0.75 per M., and the balance at $1.25 per M. The nubs brought $0.50 per M. The total value of the crop was $218.51, or $145.67 per acre.

Unsprayed fields in the vicinity of Greenlawn did not average more than 40,000 per acre. Therefore, the increase in yield due to spraying was 80,917 per acre.

YIELD OF CUCUMBERS ON THE SPRAYED FIELD AT GREENLAWN.

(One and one-half acres.)

Date.	Number picked.	Total.	Price received.	
Aug. 6..	2,100			
8..	5,800			
10..	8,400			
		16,300	Sold in N. Y. City at $1.25 (net) per M.	$20 37
13..	6,425			
15..	5,375			
17..	7,125			
19..	10,625			
20..	7,700			
22..	9,200			
23..	9,050			
25..	10,300			
26..	9,650			
27..	2,700			
29..	13,225			
31..	9,375			
Sept. 3..	16,850			
5..	8,200			
7..	7,500			
10..	10,000			
13..	6,375			
		149,675	Sold at salting house at $1.25 per M..	187 09
16..	9,100			
19..	4,300			
		13,400	Sold in N. Y. City at $0.75 (net) per M.	10 05
		2,000	Nubs sold at $0.50 per M............	1 00
Total........		181,375	Total value of crop	$218 51

Yield per acre, 120,917.
Value of crop per acre, $145.67.

PLATE XVI.—THE SPRAYED FIELD AT DEER PARK. PHOTOGRAPHED SEPT. 28.

(4) *Cost of spraying one and one-half acres at Greenlawn.*

(a) Cost of materials for spraying		$5 90
Copper sulphate	$3 60	
One barrel lime	1 50	
Expressage	80	
(b) Labor[14]		27 25
(c) Allowance for wear of spraying outfit		2 46
Total		$35 61
Cost per acre		23 74

(5) *Cost[15] of growing and gathering one and one-half acres at Greenlawn.*

Eight loads of stable manure	$18 00	
One thousand pounds of fertilizer	16 00	
Preparation of land	5 00	
Seed	1 20	
Planting	2 00	
Cultivation	7 00	
Rent of land	6 00	
Gathering crop	36 00	
		$91 20
Credit to value of stable manure for the following crop		9 00
Net cost		$82 20
Cost per acre		54 80

(6) *Profit.*

Total value of crop on one and one-half acres		$218 51
Cost of spraying one and one-half acres	$35 61	
Cost of growing and gathering one and one-half acres	82 20	
Cost of growing, gathering and spraying one and one-half acres		117 81
Net profit on one and one-half acres		$100 70
Net profit per acre		67 13

[14] Labor is estimated at $1.50 per day for a man and $3.00 per day for a team. One-half day allowed for each spraying.

[15] Estimated by D. R. Smith, the owner.

(7) *Notes on experiment at Greenlawn.*— The experiment field was situated on the farm of David R. Smith. It was triangular in shape and contained nearly one and one-half acres. For a time the stand was perfect and the plants healthy, but later in the season the bacterial or wilt disease caused some unevenness. This is shown in the photograph of the field (Plate XV). After September 13 the yield was light and the pickles had a tendency to be "nubby." This was apparently due to exhaustion of the vines and dry weather. There was very little downy mildew. On September 29 the owner pulled the vines in order to prepare the land for winter wheat. The vines were at that time still green, free from disease and bearing a few pickles. A few "withy" pickles were found where the vines were injured by the wilt disease, but no gummy pickles were found during the entire season.

THE EXPERIMENT AT DEER PARK.

(1) *Preparation and planting.*—The field, which contained two acres, was plowed once, then thirty-one tons of well rotted stable manure applied broadcast, after which the field was plowed twice more, each plowing being from five to six inches deep. The ground was thoroughly harrowed just before planting.

At the time of planting 400 pounds of fertilizer were applied in the hills. The seed[16] (Early Prolific) was planted July 1 in level hills four feet apart in the row, the rows being four feet six inches apart.

(2) *Cultivation and spraying.*—The field was cultivated with a cultivator, three times each way, and hoed once around the hills. The vines were sprayed eight times with Bordeaux mixture on the following dates: July 22 and 29; August 8, 17 and 22; and September 1, 9 and 19.

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16 The seed was purchased in Iowa for Early Prolific, but on account of the rank growth of vines and large size of the fruits the owner is of the opinion that the seed was not true to name and that the variety was in reality Long Green, or some similar variety. It is possible, however, that the rank growth of vines and fruit was due to an excess of fertility.

Plate XVII.—An Unsprayed Field at Deer Park. Photographed Sept. 28.

(3) *Yield and value of the crop.*—The first picking was made August 19. The total yield[17] of first class pickles from the two acres was 151,350, or 75,675 per acre.

The crop, not being grown under contract, was sold at prices varying from $1 to $1.50 per thousand, the total receipts being $166.48, or $83.24 per acre. The average yield of three typical unsprayed fields in the vicinity of Deer Park was 35,000 per acre. The increase in yield due to spraying was, therefore, 40,675 per acre.

YIELD OF CUCUMBERS ON THE SPRAYED FIELD AT DEER PARK.

(Two acres.)

Date.		Number picked.
August	19......	2,150
	23......	4,950
	24......	5,800
	25......	5,050
	27......	7,750
September	1......	8,050
	2......	14,400
	5......	14,800
	6......	3,600
	7......	5,350
	8......	3,600
	9......	3,300
	10......	5,850
	12......	6,800
	14......	3,000
	15......	11,100
	16......	5,600
	19......	6,600
	20......	5,400
	23......	8,500
	27......	6,500
	29......	5,500
October	5......	4,500
	12......	3,000
	17......	200
Total..........		151,350

First-class pickles sold for $166.48.
Yield per acre, 75,675.
Value of crop per acre, $83.24.

17 In addition to the yield given, it is estimated that 25,000 nubs and yellow pickles were either culled out or left on the field.

(4) *Cost of spraying two acres at Deer Park.*

(a) Cost of materials for spraying		$11 75
Copper sulphate	$8 75	
Lime	2 50	
Freightage	50	
(b) Labor (same rates as at Greenlawn)		30 00
(c) Allowance for wear of spraying outfit		2 46
Total		$44 21
Cost per acre		22 10

(5) *Cost[18] of growing and gathering two acres at Deer Park.*

Thirty-one tons stable manure	$46 50	
Four hundred pounds fertilizer	7 00	
Rent	5 00	
Plowing three times	9 00	
Preparing and planting	6 00	
Cultivating and hoeing	6 00	
Seed	2 00	
Gathering crop at $0.25 per M	37 33	
		$118 83
Credit to value of stable manure for the following crop		23 25
Net cost		$95 58
Cost per acre		47 79

(6) *Profit.*

Total value of crop on two acres		$166 48
Cost of spraying two acres	$44 21	
Cost of growing and gathering two acres	95 58	
Cost of growing, gathering and spraying two acres		$139 79
Net profit on two acres		$26 69
Net profit per acre		13 35

18 Estimated by C. W. Conklin, the owner.

(7) *Notes on experiment at Deer Park.*— The experiment field at Deer Park was on C. W. Conklin's farm. It was nearly square in form and contained two acres. No disease of any kind affected the vines and none of the pickles were gummy or withy. It was rumored that Mr. Conklin intended to pick pickles all winter. The vines were slightly injured by a light frost which occurred September 29, but were not finally killed by frost until October 17.

THE EXPERIMENT AT MATTITUCK.

(1) *Preparation and planting.*— This field, which contained two acres, scant, was on clover sod plowed June 9. On June 23 it was harrowed twice with a spading harrow and once more with a smoothing harrow just before planting.

The seed (Early Cluster) was planted July 8 in level hills four feet apart in the row, the rows being five feet apart. A good many hills failed to come up. These were replanted July 16. One-half ton of fertilizer was applied in the hills at the time of planting.

(2) *Cultivation and spraying.*— The field was cultivated three times each way with an ordinary cultivator. The vines were sprayed five times with Bordeaux mixture as follows: July 22; August 1, 9 and 17; and September 1.

(3) *Yield and value of the crop.*— The first picking was made August 26. The yield from the two acres was 41,875 large pickles, 7,080 small ones and 8,525 nubs, making a total yield of 57,480 merchantable pickles,[19] which is at the rate of 28,470 per acre. The large ones were sold under contract at $1.25 per M., the smaller ones at $0.60 per M. and the nubs at $0.50 per barrel (775 nubs made a barrel). The total value of the crop was $60.44.

The foreman of the salting house at Mattituck estimated that the average yield of unsprayed fields in that section was 40,000 per acre. Hence, the sprayed field yielded 11,260 per acre less than unsprayed fields in the same locality.

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19 Besides 35,000 (estimated) nubs and yellow pickles left on the field.

YIELD OF CUCUMBERS ON THE SPRAYED FIELD AT MATTITUCK.

(Two acres.)

Date.		Large.	Small.	Nubs.
August	26	3,925	225	.....
	27	3,900	410	.....
	29	2,550	350	.....
September	1	5,950	1,100	.....
	3	7,300	.....	775
	5	3,200	300	2,325
	7	2,300	250	775
	10	3,350	800	.....
	12	2,100	650	775
	15	2,225	900	1,550
	17	2,100	600	1,550
	19	1,100	650	775
	22	950	530	.....
	26	925	315	.....
Total		41,875	7,080	8,525

VALUE OF CROP.

40,000 large, sold at salting house at $1.25 per M.	$50 00
6,235 small, sold at salting house at $0.60 per M.	3 74
8,525 nubs (11 bbls.), sold at salting house at $0.50 per bbl.	5 50
1,875 large, 845 small, } sold in New York City	1 20
Total value of crop	$60 44
Yield per acre	28,740
Value of crop per acre	$30 22

(4) *Cost of spraying two acres at Mattituck.*

(a) Cost of materials for spraying		$5 45
Copper sulphate	$3 60	
One barrel lime	1 50	
Expressage	25	
(b) Labor (same rates as at Greenlawn)		23 40
(c) Allowance for wear of spraying outfit		2 46
Total		$31 21
Cost per acre		15 60

(5) *Cost*[20] *of growing and gathering two acres at Mattituck.*

1,000 pounds fertilizer	$12 42
Rent of land	10 00
Gathering crop	15 00
Seed	75
Preparation, planting and cultivation	20 50
Total	$58 67
Cost per acre	29 33

(6) *Loss.*

Total value of crop on two acres		$60 44
Cost of spraying two acres	$31 21	
Cost of growing and gathering two acres	58 67	
Cost of growing, gathering and spraying two acres		89 88
Total loss on two acres		$29 44
Total loss per acre		14 72

(7) *Notes on the experiment at Mattituck.*— The field at Mattituck was on the farm of A. L. Downs. It was rectangular and contained nearly two acres. At the time of the first spraying (July 23) the stand was very uneven. Many of the hills were not yet up.

The small yield of this field was not due to disease. Downy mildew appeared only in traces and there was very little wilt disease. No gummy pickles were observed. Probably, the causes of the small yield were: Late planting, poor stand and lack of fertility. As late as September 9 the plants did not cover the ground.

20 Estimated by A. L. Downs, the owner.

THE EXPERIMENT AT SMITHTOWN BRANCH.

(1) *Preparation and planting.*— The field, which contained 2.15 acres, was prepared as follows: First, a heavy coating of manure was plowed under; then the ground was harrowed four times with an " Acme " harrow, after which one-half ton of fertilizer (Quinnipiac Market Garden) per acre was applied broadcast.

The seed (Early Prolific) was planted June 23 in level hills four feet apart each way. Missing hills were replanted June 29.

(2) *Cultivation and spraying.*— After the plants were well started they were thinned to three in a hill. The field was cultivated three times each way and hoed once.

The vines were sprayed seven times, as follows: July 20 and 28; August 5, 13, 20 and 27; and September 9.

(3) *Yield and value of the crop.*— The first picking was made August 11. The total yield[20a] of first class pickles from the 2.15 acres was 143,600 or 66,790 per acre. These pickles were put into a coöperative pickle house; hence the prices will depend upon the selling price of the pickled goods. Estimating their value at $1.25 per M., the price paid at other salting houses, the value of the crop would be $179.50 or $83.49 per acre.

The average yield of unsprayed fields in the vicinity of Southtown Branch was 23,564 per acre, this being the average yield of the only four unsprayed fields, the product of which was delivered at the Smithtown salting house.

Therefore, the increase in yield due to spraying was 43,226 per acre.

20a During the hot weather about September 1, 4,000 pickles turned yellow and had to be thrown away. It was estimated that 10,000 yellow pickles and nubs were left on the field.

YIELD OF CUCUMBERS ON THE SPRAYED FIELD AT SMITHTOWN BRANCH.

(Two and fifteen one-hundredths acres.)

Date.		Number picked.	
August	11..	240	
	13..	600	
	16..	2,300	
	17..	2,000	
	19..	6,875	
	20..	8,765	
	22..	8,675	
	24..	1,000	
	25..	7,350	
	26..	8,885	
	27..	7,145	
	29..	4,625	
	30..	7,550	
	31..	4,950	
Sept.	1..	7,350	
	3..	14,995	
	5..	2,750	
	7..	5,535	
	8..	4,725	
	9..	4,035	
	12..	8,000	
	13..	4,050	
	16..	10,350	
	19..	6,250	
	26..	4,600	
Total...		143,600	First class pickles. Value, at $1.25 per M., $179.50.
			Yield per acre, 66,790. Value of crop per acre, $83.49.

(4) *Cost of spraying 2.15 acres at Smithtown Branch.*

(a) Cost of materials for spraying		$7 90
Copper sulphate	$5 70	
One barrel of lime..........................	1 50	
Freightage	70	
(b) Labor (same rate as at Greenlawn)		26 25
(c) Allowance for wear of spraying outfit		2 46
Total		$36 61
Cost per acre		17 03

(5) *Cost*[21] *of growing and gathering 2.15 acres at Smithtown Branch.*

Thirty loads of stable manure	$45 00	
One ton of fertilizer	32 00	
Preparing and planting	11 00	
Cultivation	9 00	
Three pounds of seed	90	
Gathering and marketing	43 00	
Rent of land	10 00	
		$150 90
Credit to value of stable manure for the following crop		22 50
Net cost		$128 40
Cost per acre		59 72

(6) *Profit.*

Total value of crop on 2.15 acres		$179 50
Cost of spraying 2.15 acres	$36 61	
Cost of growing and gathering 2.15 acres	128 40	
Cost of growing, gathering and spraying 2.15 acres		165 01
Net profit on 2.15 acres		$14 49
Net profit per acre		6 74

(7) *Notes on the experiment at Smithtown Branch.*— The field at Smithtown Branch was on the farm of G. W. Hallock and Son and contained 2.15 acres. Over most of the field the vines covered the ground. A little injury resulted from the wilt disease, and consequently there were a few withy pickles. No gummy pickles were found. On September 7 it was discovered that downy mildew had become established in a few spots; it did not, however, cause more than a slight amount of damage. About this time a good many pickles turned yellow on account of the excessively hot weather.

21 Estimated by G. W. Hallock, the owner.

THE PROFIT FROM SPRAYING.

In three of the above experiments — at Greenlawn, Deer Park and Smithtown Branch, spraying was certainly profitable; that is, the value of the extra yield due to spraying was considerably greater than the cost of spraying. At Greenlawn, the owner of the sprayed field received \$97.48 per acre more than his neighbors who did not spray. To get this \$97.48 per acre it cost only \$23.74, leaving a balance of \$73.74 per acre, which is net[22] profit from spraying. At Deer Park the net profit was \$22.51 per acre and at Smithtown Branch \$37.00 per acre. The experiment at Mattituck should be left out of consideration because it is perfectly plain that the crop was not properly managed. Spraying cannot supply fertility nor counteract the ill effects of late planting.

From the accompanying table it will be seen that the yield per acre at Greenlawn was nearly twice as great as at Smithtown Branch,[23] although the two fields were treated practically alike so far as spraying is concerned, each being sprayed seven times. We will not attempt an explanation of this, because it is partly a question of cultural methods, which is a subject foreign to the present discussion, but we mention it to impress the idea that spraying does not *produce* pickles; its purpose is to protect the vines from disease, thereby giving them a chance to produce all of the pickles of which they are capable under the conditions furnished by the farmer. With this fact in mind, it is plain that the farmer, himself, is an important factor in determining the amount of profit to be derived from spraying. In other words, the farmer who gives his crop the best care will get the most profit from spraying.

Another factor is the cost of spraying. The lower the cost of spraying the greater will be the profit, assuming, of course, that the spraying is properly done. The cost of spraying in these experiments is undoubtedly greater than it would be on larger fields

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22 This does not take into consideration the expense of gathering the increase.
23 Probably due in part to difference in variety grown.

in ordinary farm practice. The cost of spraying also depends to a large extent upon the way it is managed.

Still another factor is the severity of the diseases, downy mildew and anthracnose. When the diseases do not appear until the latter part of August and are mild in their attacks the profit from spraying will not be nearly so great as when the diseases appear during the first week in August and are very virulent. However, so far as Long Island is concerned, it is safe to say that the diseases will be sufficiently destructive in any season to justify the expense of spraying.

TABLE SHOWING THE INCREASE IN YIELD AND THE PROFIT FROM SPRAYING CUCUMBERS.

Location of experiment.	Yield per acre. Sprayed.	Yield per acre. Unsprayed.	Increase in yield due to spraying.	Value of the increase per acre.	Cost of spraying per acre.	Profit per acre from spraying.
Greenlawn	120,917	40,000	80,917	$97 48	$23 74	$73 74
Deer Park	75,675	35,000	40,675	44 61	22 10	22 51
Mattituck	28,740	40,000	—11,260	......	15 60	......
Smithtown Branch.	66,790	23,564	43,226	54 03	17 03	37 00

THE PROFIT IN GROWING PICKLES.

Since the yield of the late cucumbers has become so discouragingly small a great many farmers have been in doubt as to whether the crop is any longer a profitable one on Long Island. The very small crops in 1896 and 1897 caused a good many to give up pickle growing. There were many others who decided to try one more season. These have been somewhat encouraged, because the crop of 1898 was considerably better than those of the preceding two years. Our estimate of the average yield of unsprayed fields on Long Island in 1898 is 34,000 per acre. The weather conditions in 1898 were fairly good for pickles, especially the months of July and August, and since the downy mildew did not appear until about August 20, early planted fields produced a

fair yield before the vines were killed by disease. It is probable that there were a good many unsprayed fields which paid expenses and some which returned a small profit. However, it is our belief that a majority of the unsprayed fields failed to pay expenses.

In this connection it is interesting to observe how the sprayed fields came out financially. The following table shows the cost of growing and gathering, cost of spraying, value of crop and the net profit on the four experiment fields:

The Cost of Growing, Gathering and Spraying and the Profit on the Experiment Fields.

Location of experiment.	Cost per acre of growing and gathering.	Cost per acre of spraying.	Total cost per acre growing, gathering and spraying.	Value of crop per acre.	Net profit per acre.
Greenlawn	$54 80	$23 74	$78 54	$145 67	**$67 13**
Deer Park	47 79	22 10	69 89	83 24	**13 35**
Mattituck	29 33	15 60	44 93	30 22	***14 71**
Smithtown Branch..	59 72	17 03	76 75	83 49	**6 74**

* Loss.

In each case, except on the field at Mattituck (which does not count), there was a profit over and above all expenses of growing, gathering and spraying.

From observations made on cucumber spraying experiments during the past three years we believe we are safe in saying that there is considerable profit in growing pickles on Long Island at $1.25 per thousand provided spraying is practiced and the crop is given proper care.

COMMENTS ON THE COST OF SPRAYING.

Although the spraying outfits used in the four experiments were essentially identical and the fields sprayed of approximately the same size, the cost of spraying varied considerably, as may be seen from the following table:

TABLE SHOWING COST OF SPRAYING CUCUMBERS.

Location of experiment.	Area sprayed, acres.	Cost of spraying per acre.	Number of applications.	Cost per acre for each application.
Greenlawn	1.5	$23 74	7	$3 39
Deer Park	2	22 10	8	2 76
Mattituck	2	15 60	5	3 20
Smithtown Branch	2.15	17 03	7	2 43

The differences may be due in part to variation in thoroughness of spraying. The more thorough the spraying the greater the amount of labor. The facilities for obtaining water also have a bearing on the cost of spraying.

Spraying was most expensive at Greenlawn, where each application cost $3.39 per acre, and least expensive at Smithtown Branch, where it cost $2.43 per acre. The greater expense at Greenlawn is explained in part by the following: Both at Greenlawn and Smithtown Branch each application spoiled a half day, and consequently a half day's labor was charged, although the acreage at Smithtown Branch was more than one-fourth greater than at Greenlawn.

In all of these experiments one-half day was allowed for each spraying, while in no case was a full half day required to do the work. Sometimes the work was completed within two hours. Consequently, the actual cost of spraying was less than it is given in the table.

The cost might also have been lessened if the fields had been planted in such a way that a one-horse cart could have been used to haul the outfit. Such an outfit can be easily handled by one horse provided the field is not hilly, but there is a difficulty to overcome — either the cart must have a tread of sufficient width to cover two rows (which requires the wheels to be nine or ten feet apart) or else special roadways must be prepared for the passage of the cart. In a former bulletin[24] we suggested that the cucum-

[24] N. Y. Agrl. Expt. Sta. Bul. 119: 180.

bers be planted in strips of about seven rows each, leaving between the strips open spaces twelve feet in width. In the center of each open space two rows of some low growing plant, like late cabbage or cauliflower, could be planted. In fields so planted, a one-horse cart could could be used without injury to the cucumber vines.

The figures given in the above table represent the maximum cost of spraying. In practice, they can probably be reduced one-half, and, on large fields, perhaps more. For small fields of from one to two acres, knapsack sprayers do very well, but it is hard, disagreeable work to operate them.

BRIEF DIRECTIONS FOR SPRAYING CUCUMBERS ON LONG ISLAND.

Commencing some time between July 15 and August 1[25], spray thoroughly with Bordeaux mixture (1-to-8 formula) once every eight or ten days until frost. When heavy rains occur it may be necessary to spray oftener. The leaves should be kept constantly covered with Bordeaux mixture.

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25 Regardless of the age of the plants.

REPORT

OF THE

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TABLE OF CONTENTS.

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* Connected with Fertilizer-Control.

REPORT OF THE CHEMIST.

I. REPORT OF ANALYSES OF COMMERCIAL FERTILIZERS FOR THE SPRING OF 1898.*

L. L. Van Slyke.

SUMMARY.

(1) Samples Collected. During the spring of 1898, the Station collected 1183 samples of commercial fertilizers, representing 739 different brands. Of these different brands, 578 were complete fertilizers; of the others, 55 contained phosphoric acid and potash without nitrogen; 47 contained nitrogen and phosphoric acid without potash; 8 contained nitrogen only; 44 contained phosphoric acid alone, and 7 contained potash salts only.

(2) Nitrogen. The 578 brands of complete fertilizers contained nitrogen varying in amount from 0.12 to 8.21 per cent, and averaging 2.20 per cent. The average amount of nitrogen found by the Station analysis exceeded the average guaranteed amount by 0.14 per cent, the guaranteed average being 2.06 per cent and the average found being 2.20 per cent.

In 395 brands of complete fertilizers, the amount of nitrogen found was equal to or above the guaranteed amount, the excess varying from 0.01 to 3.27 per cent, and averaging 0.28 per cent.

* Reprint of Bulletin No. 145.

In 168 brands the nitrogen was below the guaranteed amount, the deficiency varying from 0.01 to 1.64 per cent and averaging 0.21 per cent. In 156 cases, the deficiency was less than 0.5 per cent.

The amount of water soluble nitrogen varied from 0 to 5.03 per cent and averaged 0.94 per cent.

(3) Available Phosphoric Acid. The 578 brands of complete fertilizers contained available phosphoric acid varying in amount from 3.69 to 14.28 per cent and averaging 8.65 per cent. The average amount of available phosphoric acid found by the Station analysis exceeded the average guaranteed amount by 1 per cent; the guaranteed average being 7.65 per cent and the average found being 8.65 per cent.

In 468 brands of complete fertilizers, the amount of available phosphoric acid found was above the amount guaranteed, the excess varying from 0.03 to 6.52 per cent and averaging 1.23 per cent.

In 89 brands, the available phosphoric acid was below the guaranteed amount, the deficiency varying from 0.01 to 2.13 per cent and averaging 0.43 per cent. In 63 cases the deficiency was below 0.5 per cent.

The amount of water soluble phosphoric acid varied from 0.10 to 11.11 per cent and averaged 5.08 per cent.

(4) Potash. The complete fertilizers contained potash varying in amount from 0.22 to 15.22 per cent. and averaging 4.91 per cent. The average amount of potash found by the Station analysis exceeded the average guaranteed amount by 0.24 per cent, the guaranteed average being 4.67 per cent and the average found being 4.91 per cent.

In 426 brands of complete fertilizers, the amount of potash found was above the guaranteed amount, the excess varying from 0.01 to 3.15 per cent and averaging 0.55 per cent.

In 140 brands, the potash was below the guaranteed amount, the deficiency varying from 0.01 to 4.48 per cent and averaging

0.50 per cent. In 121 of these cases, the deficiency was less than 0.5 per cent.

In 110 cases among the 578 brands of complete fertilizers the potash was contained in the form of sulphate free from an excess of chlorides.

(5) The retail selling price of the complete fertilizers varied from \$15 to \$45 a ton and averaged \$27.65. The retail cost of the separate ingredients unmixed averaged \$18.52, or \$9.13 less than the selling price.

INTRODUCTION.

NUMBER AND KINDS OF FERTILIZERS.

During the spring of 1898, the Station's collecting agents visited 206 towns between March 23 and June 8, obtaining 1,183 samples of commercial fertilizers. These samples represent 739 different brands, the product of 123 different manufacturers, each manufacturer being represented by from 1 to 49 brands.

The subjoined tabulated statement indicates the different classes included in the collection.

CLASSES OF FERTILIZERS COLLECTED.

Brands containing only nitrogen	Brands containing only phosphoric acid.	Brands containing only potash.	Brands containing nitrogen and phosphoric acid without potash.	Brands containing phosphoric acid and potash without nitrogen.	Brands of complete fertilizers.
8	44	7	47	55	578

From these figures it can be seen that 78 per cent of the commercial fertilizers offered for sale during the spring consisted of complete fertilizers. The remaining 22 per cent was distributed in nearly equal proportions between acid phosphates, bone and mixtures containing acid phosphate and potash.

COMPOSITION OF FERTILIZERS COLLECTED.

The following tabulated statements show the average composition of the fertilizers collected during the spring, together with a comparison of the guaranteed composition and that found by analysis.

AVERAGE COMPOSITION OF COMPLETE FERTILIZERS COLLECTED.

	Per cent guaranteed.			Per cent found.			Average per cent found above guarantee.
	Lowest.	Highest.	Average.	Lowest.	Highest.	Average.	
Nitrogen	0.40	8.78	2.06	0.12	8.21	2.20	0.14
Available phosphoric acid	3.00	14.00	7.65	3.69	14.28	8.65	1.00
Insoluble phosphoric acid	....	....	....	0.00	10.75	1.90	....
Potash	0.50	15.00	4.67	0.22	15.22	4.91	0.24
Water-soluble nitrogen	....	....	....	0.00	5.03	0.94	....
Water-soluble phosphoric acid	....	....	....	0.10	11.11	5.08	....

The following statements, applying to the complete fertilizers, are of interest in connection with this table:

(1) The nitrogen was above the guarantee in 70 per cent of the samples and in 2 per cent it was below the guarantee by one-half of one per cent or more.

(2) The available phosphoric acid exceeded the guarantee in 81 per cent of the samples, and in 4.5 per cent it was one and one-half per cent or more below the guarantee.

(3) The potash was above the guarantee in 74 per cent of the samples, and in 3.3 per cent it was one-half of one per cent or more below the guarantee.

AVERAGE COMPOSITION OF CHEMICALS AND INCOMPLETE FERTILIZERS.

	Per cent guaranteed.			Per cent found.			Average per cent found above guarantee.
	Lowest.	Highest.	Average.	Lowest.	Highest.	Average	
Nitrogen in							
Nitrate of soda....	14.76	15.50	15.16	14.80	15.61	15.42	0.26
Sulphate of ammonia	.....	.....	20	.....	.....	20.34	0.34
Dissolve phosphates							
Phosphoric acid ...	.....	.....	.....	.....	.....	.....	....
Available	10	30	13.50	11.05	33.27	14.36	0.86
Water-soluble	.....	.....	.....	0.37	15.55	9.30	....
Insoluble	.....	.....	.....	0.16	3.81	1.38	....
Potash in							
Kainit	12.40	12.40	12.40	11.94	17.36	12.75	0.35
Muriate	50	50.40	50.20	49.74	50.20	50	....
Sulphate	.....	.....	22.50	.....	.....	20.60	....
Fish scrap							
Nitrogen	5	8.50	7.17	5.35	9	7.68	0.51
Phosphoric acid....	4	6	5.34	3.84	7.23	5.20	....
Bone meal							
Nitrogen	1	4	2.50	1.05	4.77	2.95	0.45
Phosphoric acid....	9	26.67	19.10	10.93	28.83	21.32	2.22
Mixture containing							
Phosphoric acid ...	.....	.....	.....	.....	.....	.....	....
Available	8	13	10	7.46	13.46	10.80	0.80
Insoluble	.....	.....	.....	0.21	9.50	2.67	....
Potash	1	10	3.60	0.84	9.85	3.72	0.12

TRADE-VALUES OF PLANT-FOOD ELEMENTS IN RAW MATERIALS AND CHEMICALS.

The trade-values in the following schedule have been agreed upon by the Experiment Stations of Massachusetts, Rhode Island, Connecticut, New York, New Jersey and Vermont, as a result of study of the prices actually prevailing in the large markets of these states.

These trade values represent, as nearly as can be estimated, the average prices at which, during the six months preceding March, the respective ingredients, *in the form of unmixed raw materials,* could be bought at retail for cash in our large markets. These prices also correspond (except in case of available phosphoric acid) to the average wholesale prices for the six months preceding March plus about 20 per cent in case of goods for which there are wholesale quotations.

TRADE-VALUES OF PLANT-FOOD ELEMENTS IN RAW MATERIALS AND CHEMICALS.

	1898. Cts. per pound.
Nitrogen in ammonia salts	14
Nitrogen in nitrates	13
Organic nitrogen in dry and fine-ground fish, meat and blood, mixed fertilizers	14
Organic nitrogen in cotton-seed meal and castor-pomace	12
Organic nitrogen in fine-ground bone and tankage	13½
Organic nitrogen in coarse bone and tankage	10
Phosphoric acid, water-soluble	4½
Phosphoric acid, citrate-soluble	4
Phosphoric acid in fine-ground fish, bone and tankage	4
Phosphoric acid in coarse fish, bone and tankage	3½
Phosphoric acid in cotton-seed meal, castor-pomace and wood ashes	4
Phosphoric acid in mixed fertilizers, insoluble in ammonium citrate	2
Potash as high-grade sulphate, in forms free from muriates (chlorides), in ashes, etc	5
Potash in muriate	4¼

COMPARISON OF SELLING PRICE AND COMMERCIAL VALUATION.

Giving to the different constituents the values assigned in the schedule for mixed fertilizers, 14 cents a pound for nitrogen, 4 1-2 cents a pound for water-soluble phosphoric acid, 4 cents a pound for citrate soluble phosphoric acid, 2 cents a pound for insoluble phosphoric acid, and 4 1-4 cents a pound for potash, we can calculate the commercial valuation, or the price, at which the separate unmixed materials contained in one ton of fertilizer, having the composition indicated in the preceding table, could be purchased for cash at retail at the seaboard. Knowing the retail prices at

which these goods were offered for sale, we can also readily estimate the difference between the actual selling price of the mixed goods and the retail cash cost of the unmixed materials; the difference covers the cost of mixing, freight, profits, etc. We present these data in the following tables:

COMMERCIAL VALUATION AND SELLING PRICE OF COMPLETE FERTILIZERS.

Commercial valuation of complete fertilizer.	Selling price of one ton of complete fertilizer.			Averaged increased cost of mixed materials over unmixed material for one ton.
Average.	Lowest.	Highest.	Average.	
$18 52	$15 00	$45 00	$27 65	$9 13

COMMERCIAL VALUATION AND SELLING PRICE OF CHEMICALS AND INCOMPLETE FERTILIZERS.

	Commercial valuation.			Selling price.			Average increase of selling price over commercial valuation.
	Lowest.	Highest.	Average	Lowest.	Highest.	Average.	
Nitrate of soda	$38 48	$40 40	$39 44	$38 75	$40 00	$39 38	*$0 06
Sulphate of ammonia.	......	......	56 95	......	......	60 00	3 05
Dissolved phosphate.	10 25	26 65	12 97	11 00	26 00	15 90	2 93
Kainit	......	......	10 84	......	......	15 00	4 16
Muriate of potash...	......	......	42 67	......	......	40 00	*2 67
Fish-scrap..........	18 05	30 14	25 67	14 00	26 00	21 67	*4 00
Bone-meal..........	11 94	30 41	25 32	20 00	38 00	27 70	2 38
Mixture containing phosphoric acid and potash	8 93	18 38	12 70	16 00	30 00	20 66	7 96
Wood-ashes	3 03	8 37	5 77	9 00	12 00	10 30	4 53

* Commercial valuation greater than selling price.

COST OF ONE POUND OF PLANT FOOD IN FERTILIZERS AS PURCHASED BY CONSUMERS.

In the table below we present figures showing the lowest, highest and average cost to the purchaser of one pound of plant-food in different forms.

COST OF ONE POUND OF PLANT-FOOD TO CONSUMERS.

	Lowest.	Highest.	Average
	Cents.	*Cents.*	*Cents.*
Nitrogen in			
Complete fertilizers	11.7	38.2	21
Bone-meal	10.6	26.7	14.7
Fish-scrap	10.9	12	11.8
Nitrate of soda	12.9	13.1	13
Sulphate of ammonia	....	....	14.7
Phosphoric acid in			
Complete fertilizers (available)	3.6	11.6	6.5
Dissolved phosphates (available)	3.8	10	4.9
Fish-scrap (total)	3.1	3.5	3.3
Bone-meal (total)	3	7.6	4.2
Phosphoric acid and potash mixtures (available)	5.3	12.6	7.3
Wood-ashes (total)	4.3	13.9	7.2
Potash in			
Complete fertilizers	3.75	12.3	6.75
Kainit	....	....	5.9
Muriate of potash	....	....	4
Wood-ashes	5.4	17.4	9
Potash and phosphoric acid mixtures	5	11.9	6.9

PURCHASE OF PLANT-FOOD.

The data contained in some of the preceding tables afford a good basis for calling the attention of farmers to certain facts and for making suggestions connected with the purchase of plant-food.

(1) *Farmers are advised, before purchasing, to obtain for themselves prices at which they can actually buy plant-food.* It should be kept in mind that the prices given as trade values in Station bulletins are only averages and do not represent accurately all conditions of the market without regard to time or place. Actual trade values necessarily vary with localities and with different times of the year. The true values to use in making a commercial valuation of plant-food are those figures which represent the actual prices at which the farmer can purchase the elements of plant-food at a given time. Quotations should be obtained by making inquiries of several manufacturers, asking at what prices they will furnish the specific forms of plant-food that one wishes

to use. The prices thus found enable the farmer to make out his own schedule of valuations and they apply accurately to his special conditions.

Attention is here called to a serious abuse of the schedule of valuations published by the Station. In some instances fertilizer manufacturers have used in their printed circulars schedule prices which had been published some years previous, when the prices were considerably higher, and they have quoted these as being authorized by the Station. Using these old figures as a basis for making a commercial valuation of their goods, they have obtained figures which represented their fertilizers as selling for less than they were actually worth. Whenever our attention has been called to this form of imposition, we have stopped it. It has also been reported that some agents use the same means in selling goods to farmers, showing one of the Station bulletins and quoting its figures. If farmers will keep themselves informed either by consulting our latest bulletins or by ascertaining for themselves, as suggested above, the latest prices direct from large dealers, they need not be the victims of overzealous agents.

(2) *Shall farmers purchase mixed fertilizers or unmixed materials?*

It has been represented to farmers that peculiar virtues are imparted to the elements of plant-food by proper mixing and that this proper mixing can be accomplished only by means not at the command of farmers. Such statements are misrepresentations, based either upon the ignorance of the person who makes them or upon his anxiety to sell mixed goods. Nitrate of soda, for illustration, does its work in plant nutrition in exactly the same manner whether it is added to the soil as part of a mixture or whether the ingredients of the mixture are applied separately. The availability of plant-food is not usually affected by mixing. Other conditions determine whether a fertilizer shall be applied in mixed form or in separate materials.

As to the ability of farmers to mix their own fertilizers, no doubt exists except in the minds of those who desire to sell goods

ready mixed. The main consideration that presents itself as between purchasing mixed and unmixed forms of plant-food is the question of economy. What do the figures published above show on this point?

(*a*) Each pound of nitrogen in mixed fertilizers costs the farmer in this State this year 21 cents, on an average, while the schedule price is 14 cents. Hence, on an average, farmers paid for their nitrogen in mixed goods, at least one and one-half times as much as it would have cost them in unmixed forms.

(*b*) Each pound of available phosphoric acid in mixed fertilizers costs the farmer 6 1-2 cents and in dissolved phosphate, purchased from retail dealers, it costs not quite 5 cents; while, purchased at schedule prices, it would be 4 1-2 cents; but as a matter of fact farmers were able to purchase available phosphoric acid in the form of dissolved rock for 3 1-2 cents and even less, or at about one-half the price which they paid for it in mixed fertilizers.

In this connection, it may be well to state that soluble phosphoric acid has the same value, pound for pound, whatever its source. At present dissolved rock is the cheapest source and this is the form in which farmers should buy phosphoric acid, if they desire to receive the largest amount of actual plant-food for their money.

(*c*) Each pound of potash, mostly in form of muriate, costs the farmer 6 3-4 cents in mixed fertilizers, while in one sample of muriate purchased the cost was 4 cents.

It can readily be seen that, in point of economy, under the conditions actually prevailing at present, farmers can buy their plant-food at much lower prices in unmixed forms than in mixed goods, even when purchasing from retail agents.

(3) *How can plant-food be purchased most cheaply?*

If each farmer by himself buys plant-food, he can undoubtedly secure most economical results by getting unmixed materials. Still better prices can be realized by coöperation. Attention was called in Bulletin No. 94 to the Riverhead Town Agricultural

Society of Long Island, which has for years successfully followed the plan of coöperation. This year its members bought, in the form of a mixed fertilizer made according to contract, nitrogen for 11.7 cents a pound, available phosphoric acid for 3.6 cents a pound and potash as muriate for 3.75 cents a pound. It will be noticed that these prices are a little more than one-half those paid for plant-food by the average farmer purchasing mixed fertilizers in the ordinary way. The members of this club paid $24.45 for each ton of fertilizer, which would have cost farmers, buying at the average prices paid for plant-food, $44.67.

(4) It is a matter of interest to notice that farmers who purchase mixtures containing only phosphoric acid and potash are compelled to pay even higher prices for each pound of plant-food than in complete fertilizers. Thus, each pound of available phosphoric acid costs 7.3 cents and each pound of potash 6.9 cents. These goods are often put on the market under fanciful names and sold at prices varying from $16 to $30 a ton and averaging nearly $21.

(5) Manufacturers of fertilizers, whose goods are sold in New York State, put out, at least on paper, 1900 different brands. Many of these are not on sale in this State, but the number of different brands actually in the market of the State is very large. These are mixtures made mostly from a few materials, most of which are in open market and accessible to farmers. The needs of all our different crops could be quite adequately met by less than a dozen different mixtures and yet there are in the market more than a hundred times this number. In other words, the thousand or two brands of commercial fertilizers could be reduced to a dozen or less and the needs of the farmers more effectually supplied. This absurd multiplicity of brands is in itself a strong reason why the farmer should bestow some independent study upon the plant-food requirements of crops and should exercise intelligence in purchasing his supplies of plant-food.

LIST OF MANUFACTURERS WHO HAVE FILED STATEMENTS REQUIRED BY LAW.

Manufacturers to the number of 193 have filed with this Station the statement required by law. Of these there are 62 whose factories are located outside of New York State. These 193 manufacturers put on the market 1,900 different brands. Many of these brands are manufactured for special parties in other states, so that the number of different brands actually sold in this State is short of the total given above. Within the past three years it has become very common to have special goods made for local dealers which have a limited sale in the dealer's immediate locality. This method is becoming more and more common, and, of course, increases largely the number of brands made and sold.

Names and Addresses of Manufacturers.	No. of brands reported
G. H. Ackerman, Lacona, N. Y.	2
Acme Fertilizer Co., 62 William street, New York city	7
Allentown Manufacturing Co., Allentown, Pa.	1
American Cotton Oil Co., 47 Cedar street, New York city	1
American Reduction Co., 1516 Second avenue, Pittsburg, Pa.	4
Armour Fertilizer Works, 205 La Salle street, Chicago, Ill.	13
Edward J. Attwood, Andover, N. Y.	7
Bachman & Co., Chester, Orange county, N. Y.	2
A. M. Baker & Son, Mt. Morris, N. Y.	20
H. J. Baker & Bro., 93 William street, New York city	27
Berkshire Mills Co., Bridgeport, Conn.	4
Geo. W. Berry, Poolville, N. Y.	1
J. W. Bingham, Marlborough, N. Y.	6
Edwin Blakely, Otego, N. Y.	5
Bowker Fertilizer Co., 43 Chatham street, Boston, Mass.	98
Bradley Fertilizer Co., 92 State street, Boston, Mass.	34
The Bradley Fertilizer Co., of Philadelphia, Philadelphia, Pa.	9
A. M. Breed, Big Flats, N. Y.	1
W. A. Brown, Preston, N. Y.	3
Brumfield & Foster, Colora, Md.	7
J. P. Butts, Oneonta, N. Y.	7
Campbell & Pulver, Italy Hill, N. Y.	9
Cuyler E. Carr, Milford, N. Y.	3
F. A. Cheesbro, Penfield, N. Y.	1
Chemical Co., of Canton, Baltimore, Md.	11
Chicopee Guano Co., 88 Wall street, New York city	6
Clark & Powers, Fabius, N. Y.	1

Names and Addresses of Manufacturers.	No. of brands reported
Clark's Cove Fertilizer Co., 40 Exchange place, New York city....	16
Cleveland Dryer Co., 92 State street, Boston, Mass................	12
Club & Grange Fertilizer Co., Syracuse, N. Y....................	5
E. Frank Coe Co., 135 Front street, New York city................	43
Edwin Collier, Morris, N. Y..	1
Peter Cooper's Glue Factory, 13 Burling slip, New York city......	1
A. S. Core Fertilizer Works, White Plains, N. Y..................	13
T. L. Corwin & Son, Marathon, N. Y............................	4
James Craib, Brighton, N. Y...................................	1
Crocker Fertilizer & Chemical Co., Buffalo, N. Y................	123
E. A. Cross, Hilton, N. Y..	3
Cuba Fertilizer Co., Cuba, N. Y.................................	8
Cumberland Bone Phosphate Co., Portland, Me..................	23
Edward Cutcliffe, East Bethany, N. Y............................	1
L. B. Darling Fertilizer Co., Pawtucket, R. I....................	10
Detrick Fertilizer & Chemical Co., Baltimore, Md.	27
Louis F. Detrick, Baltimore, Md..................................	6
P. P. Dunan, Baltimore, Md......................................	6
J. W. Dunbar, Attica, N. Y.......................................	1
Edward Dwyer, Livonia, N. Y....................................	6
Eastern Farm Supply Association, Montclair, N. J................	10
Robert D. Eaton, Norwich, N. Y.................................	15
Elixir Fertilizer Co., 107 W. Fourteenth street, New York city......	1
Frank T. Ellison, Rochester, N. Y...............................	2
Erie City Fertilizer Works, Erie, Pa.............................	5
Farmers and Builders' Supply Co., Owego, N. Y..................	6
Farmers' Fertilizer and Chemical Co., Syracuse, N. Y..............	18
Farmers' Union Fertilizer Works, Buffalo, N. Y.................	6
Louis Fechter, East Buffalo, N. Y...............................	1
John Finster, Rome, N. Y..	1
Henry Fitchard, Minetto, N. Y..................................	1
Geo. B. Forrester, 159 Front street, New York city...............	25
Geneva Coal Co., Geneva, N. Y.................................	12
A. C. Geslain, 131 Rutledge street, Brooklyn, N. Y................	2
Globe Fertilizer Co., New York city..............................	13
Great Eastern Fertilizer Co., Rutland, Vt.........................	15
Griffith & Boyd, 9 South Gay street, Baltimore, Md...............	15
John Haefele, Delaware avenue, Albany, N. Y....................	1
Ira C. Hall, Farmer, N. Y..	8
Hammond's Slug-Shot Works, Fishkill Landing, N. Y.............	1
Hanlon Bros., Medina, N. Y......................................	5
John Hardiman, New Hartford, N. Y.............................	2
Geo. L. Harding, Binghamton, N. Y..............................	1
G. W. Harris, Webster, N. Y......................................	3
Hathaway & Reynolds, Oriskany Falls, N. Y......................	5
Isaac C. Hendrickson, Jamaica, N. Y.............................	1

Names and Addresses of Manufacturers.	No. of brands reported.
S. M. Hess & Bro., Fourth and Chestnut streets, Philadelphia, Pa.	14
Hewitt Bros., Locke, N. Y.	4
C. C. Hicks, Penn Yan, N. Y.	7
Clark L. Horton, Afton, N. Y.	4
Hubbard & Co., 10 Light street, Baltimore, Md.	10
Humphrey & Holdridge, Honeoye Falls, N. Y.	6
Imperial Fertilizer Co., 5 Hanover street, New York city	2
Ingersoll Packing Co., Ingersoll, Ont., Can.	4
International Seed Co., Rochester, N. Y.	4
F. N. Isham, Avon, N. Y.	1
Jamestown Fertilizer Co., Jamestown, N. Y.	4
The Jarecki Chemical Co., Sandusky, Ohio	10
The Jones Fertilizing Co., Union Stock Yards, Cincinnati, Ohio	8
F. W. Jones, Jonesburg, N. Y.	4
Lackawanna Fertilizer and Chemical Co., Moosic, Pa.	6
F. R. Lalor, Dunnville, Ont., Can.	1
Lazaretto Guano Co., Baltimore, Md.	41
Liebig Manufacturing Co., 26 Broadway, New York city	10
Lister's Agricultural Chemical Works, Newark, N. J.	34
Joseph Lister, 1158 Elston avenue, Chicago, Ill.	1
Locke Fertilizer Co., Locke, N. Y.	8
Lonergan & Livingston, Albany, N. Y.	2
Long Island Agricultural Chemical Co., Long Island City, N. Y.	4
Lowell Fertilizer Co., Lowell, Mass.	13
Fred'k Ludlam, 108 Water street, New York city	8
Zeph. F. Magill, Troy, N. Y.	1
Mapes Formula and Peruvian Guano Co., 143 Liberty street, New York city	24
Maryland Fertilizing and Manufacturing Co., 30 So. Holliday street, Baltimore, Md.	19
Maxson & Starin, Cortland, N. Y.	19
H. E. Meyer, Middletown, N. Y.	1
Michigan Carbon Works, Detroit, Mich.	12
Miller Fertilizer Co., 411 East Pratt street, Baltimore, Md.	9
Milson Rendering and Fertilizer Co., East Buffalo, N. Y.	40
Minot & Decker, Brockport, N. Y.	2
L. Mittenmaier & Son, Rome, N. Y.	4
Moller & Co., Maspeth, N. Y.	2
Geo. L. Munroe, Oswego, N. Y.	1
National Fertilizer Co., Bridgeport, Conn.	4
Newburgh Rendering Co., Newburgh, N. Y.	1
Niagara Fertilizer Works, Buffalo, N. Y.	28
Northwestern Fertilizer Co., Chicago, Ill.	14
Oakfield Fertilizer Co., Swan and Washington streets, Buffalo, N. Y.	9
Oneonta Fertilizer and Chemical Co., Oneonta, N. Y.	18
Overton & Co., Reading Center, N. Y.	1

Names and Addresses of Manufacturers.	No. of brands reported.
Pacific Guano Co., 27 William street, New York city	29
Packers' Union Fertilizer Co., New York city	8
Patapsco Guano Co., Baltimore, Md	16
G. A. Pearsall, Williamson, N. Y	4
A. W. Perkins & Co., Rutland, Vt	1
W. P. Perkins, 366 Ninth street, Brooklyn, N. Y	1
A. Peterson, Penfield, N. Y	3
J. E. Phelps, Jamaica, N. Y	7
Phelps Fertilizer Co., Phelps, N. Y	2
Moro Phillips Chemical Co., 131 So. Third street, Philadelphia, Pa.	17
Wm. W. Phipps, Albion, N. Y	7
H. A. Pierce & Co., Armor, N. Y	5
B. J. Pine, East Williston, N. Y	2
L. S. Pitkin, Lorraine, N. Y	1
Potomac Fertilizer Co., Baltimore, Md	47
Preston Fertilizer Co., Long Island city, N. Y	14
Queen City Fertilizer Co., 564 Washington street, Buffalo, N. Y	15
Quinnipiac Co., 83 Fulton street, New York city	42
Rasin Fertilizer Co., Baltimore, Md	10
Read Fertilizer Co., 88 Wall street, New York city	54
John S. Reese & Co., Baltimore, Md	19
J. L. Richer, New Berlin, N. Y	3
Riverside Acid Works, Warren, Pa	4
Rochester Fertilizer Works, Rochester, N. Y	14
Rogers & Hubbard Co., Middletown, Conn	9
Lucien Sanderson, New Haven, Conn	2
The Scientific Fertilizer Co., Pittsburg, Pa	6
Sessions & Leonard, Palmyra, N. Y	2
Sharpless & Carpenter, 24 So. Delaware avenue, Philadelphia, Pa.	14
M. L. Shoemaker & Co., Philadelphia, Pa	3
Chas. A. Sickler & Bro., Wilkesbarre, Pa	6
Isaac Smith, Columbiaville, N. Y	12
W. H. Stamp, Warsaw, N. Y	6
Standard Fertilizer Co., Boston, Mass	27
H. Stappenbeck, Utica, N. Y	3
Sterling Oil Co., Greenport, N. Y	1
Geo. Stevens, Peterborough, Ont., Can	2
W. B. Stewart, South Plymouth, N. Y	3
Swift & Co., Chicago, Ill	10
C. R. Sworts, Dundee, N. Y	3
F. W. Tassel, Williamson, N. Y	2
J. P. Thomas & Son Co., 2 So. Delaware avenue, Philadelphia, Pa.	14
S. G. Titus, Rochester, N. Y	1
Edward D. Tolles, Attica, N. Y	12
Henry F. Tucker & Co., Boston, Mass	24
Geo. O. P. Turner, Churchville, N. Y	8

Names and Addresses of Manufacturers.	No. of brands reported.
E. Tuthill & Co., Promised Land, N. Y.	12
Geo. F. Tuthill & Co., Greenport, N. Y.	1
J. E. Tygert & Co., 42 So. Delaware avenue, Philadelphia, Pa.	9
Tygert-Allen Fertilizer Co., 2 Chestnut street, Philadelphia, Pa.	20
F. G. Underwood, Oneida, N. Y.	4
J. E. Van Benthuysen, Lishaskill, N. Y.	3
J. W. Van Cott & Son, Unadilla, N. Y.	3
Walker Fertilizer Co., Clifton Springs, N. Y.	16
Walker, Stratman & Co., Pittsburg, Pa.	7
Robert West, Buffalo, N. Y.	2
W. E. Whann, William Penn, Pa.	9
W. E. Wheeler & Co., Rutland, Vt.	11
The Wilcox Fertilizer Works, Mystic, Conn.	3
Willoughby & Fletcher, Oxford, N. Y.	3
Wilkinson & Co., 29 So. William street, New York city.	2
Williams & Clark Fertilizer Co., 27 William street, New York city.	48
M. J. Wood, Fairport, N. Y.	1
Wooster & Mott, Union Hill, N. Y.	6
York Chemical Works, York, Pa.	4
Zell Guano Co., Baltimore, Md.	49

TERMS USED IN STATING RESULTS OF ANALYSIS.

In the tables following, the terms used to express the results of analysis are self-explanatory for the most part. Attention is called, however, to "water-soluble" phosphoric acid and nitrogen.

While manufacturers are required to guarantee only the amount of available phosphoric acid (water-soluble plus reverted or citrate-soluble), yet it seems desirable that consumers should know what proportion of the available is water-soluble. The amounts of available phosphoric acid being equal, one would choose by preference a fertilizer containing the larger amount of water-soluble phosphoric acid.

The amount of water-soluble phosphoric acid varied from 0.1 to 11.11 per cent and averaged 5.08 per cent. This constituted nearly 60 per cent of the available phosphoric acid present.

The water-soluble nitrogen includes nitrogen present in the form of ammonia salts and nitrogen together with that present in small amounts of soluble organic matter. The amount of water-

soluble nitrogen varied from 0 to 5.03 per cent and averaged 0.94 per cent. This constituted 43.2 per cent of the total nitrogen present. It should not be inferred that water-soluble nitrogen is of more value than the rest. It is, of course, more readily available, so far as it consists of nitrates, but it must be remembered that nitrogen in this form leaches and is lost to plants more readily than nitrogen in other forms.

RESULTS OF ANALYSIS OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Acme Fertilizer Co., Maspeth, N. Y.	Acme fertilizer No. 1.	Jamaica.	4074
Acme Fertilizer Co., Maspeth, N. Y.	Acme fertilizer No. 2.	Jamaica.	4075
Acme Fertilizer Co., Maspeth, N. Y.	High-grade special.	Jamaica.	4076
Acme Fertilizer Co., Maspeth, N. Y.	Potato special.	Bridgehampton.	4169
Acme Fertilizer Co., Maspeth, N. Y.	Superior superphosphate.	Bridgehampton.	4170
American Reduction Co., Pittsburg, Pa.	Powter brand.	North Collins.	5049
The Armour Fertilizer Works, Chicago, Ill.	All soluble.	Binghamton. Middletown.	4343 4987
The Armour Fertilizer Works, Chicago, Ill.	Ammoniated bone with potash.	Middletown.	4986
The Armour Fertilizer Works, Chicago, Ill.	Bone, blood and potash.	Livonia Station. Middletown. Bliss.	4607 4989 5109

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	3.70	8	—	9*	—	—
Found	4.45	8.23	8.58	8.24	2.56	6.97
Below guarantee				0.76		
Guaranteed	4.95	8	—	5*	—	—
Found	5.33	8.79	9.21	4.96	3.64	9.37
Guaranteed	7.40	7	—	4	—	—
Found	7.27	7.50	8.11	4.23	4.83	5.84
Guaranteed	3.29	5	—	9*	—	—
Found	3.29	8.14	8.76	9.76	1.51	5.67
Guaranteed	1.23	6	—	4*	—	—
Found	2.14	9.83	12.18	4.14	0.74	5.21
Guaranteed	1.20	8	—	1.50	—	—
Found	1.74	6.13	8.72	2.09	0.46	3.63
Below guarantee		1.87				
Guaranteed	2.88	8	—	4*	—	—
Found	3.32	8.12	10.34	6.09	1.92	3.57
Guaranteed	2.47	6	—	2*	—	—
Found	3.06	5.81	13.37	3.26	0.15	0.63
Guaranteed	4.11	8	—	7*	—	—
Found	3.96	9.88	10.88	7.66	1.08	7.29

* Potash present in form of sulphate.

RESULTS OF ANALYSIS OF COMMERCIAL FERTILIZERS

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
The Armour Fertilizer Works, Chicago, Ill.	Bone meal.	Binghamton.	4345
The Armour Fertilizer Works, Chicago, Ill.	Grain grower.	Binghamton. Avon. Gowanda.	4344 4591 4985
Edward J. Attwood, Andover, N. Y.	New York standard No. 2.	Andover.	4762
Bachman & Co., Chester, N. Y.	Successor.	Chester.	4975
A. M. Baker & Son, Mt. Morris, N. Y.	Market garden special.	Moscow.	4633
A. M. Baker & Son, Mt. Morris, N. Y.	Onion and celery fertilizer.	Mt. Morris.	4627
A. M. Baker & Son, Mt. Morris, N. Y.	Ontario.	Mt. Morris.	4634
A. M. Baker & Son, Mt. Morris, N. Y.	Ten and ten phosphate.	Mt. Morris.	4628
H. J. Baker & Bro., New York City.	A A ammoniated superphosphate.	Mineola.	4117

COLLECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

IN 100 POUNDS OF FERTILIZER.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	2.47	10	24	——	——	——
Found	2.89	10.82	26.14		0.21	
Guaranteed	1.64	8	——	2*	——	——
Found	1.91	8.61	11.34	2.49	0.60	0.90
Guaranteed	1.23	10	——	3	——	——
Found	1.33	9.17	11.04	3.25	0.42	6.36
Below guarantee		0.83				
Guaranteed	1.02	——	4	1.14	——	——
Found	0.19		2.79	1.50	0	
Below guarantee	0.83		1.21			
Guaranteed	3.70	8	——	8	——	——
Found	3.52	8.40	11.07	10.92	0.95	5.83
Guaranteed	2.87	8	——	12	——	——
Found	3.92	8.58	11.55	11.80	0.68	5.48
Guaranteed	1.03	10	——	4	——	——
Found	1.39	12.70	13.38	4.41	0.53	9.59
Guaranteed	——	10	——	10	——	——
Found		12.13	12.34	9.85		8.90
Guaranteed	2.47	10	——	2	——	——
Found	2.77	10.82	11.80	2.80	1.62	7.98

* Potash present in form of sulphate.

RESULTS OF ANALYSIS OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
H. J. Baker & Bro., New York City.	Cabbage manure.	Jamaica.	4080
H. J. Baker & Bro., New York City.	Complete corn manure.	Poughkeepsie	4240
H. J. Baker & Bro., New York City.	Complete cucumber manure.	Viola.	4972
H. J. Baker & Bro., New York City.	Complete manure for general use.	White Plains. Albany.	4206 4488
H. J. Baker & Bro., New York City.	Complete nitrogenized manure.	Jamaica.	4081
H. J. Baker & Bro., New York City.	Complete potato manure.	Jamaica.	4079
H. J. Baker & Bro., New York City.	Damaraland guano.	Jamaica.	4097
H. J. Baker & Bro., New York City.	Harvest home.	Mineola.	4118
H. J. Baker & Bro., New York City.	Kainit.	Riverhead.	4129

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

IN 100 POUNDS OF FERTILIZER.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	4.75	5	—	7	—	—
Found	4.65	6.47	6.95	7.82	3.02	5.39
Guaranteed	4.11	6.25	—	7	—	—
Found	3.81	7.24	7.73	7.50	2.30	6.16
Below guarantee	0.30					
Guaranteed	4.75	5	—	7*	—	—
Found	4.64	6.55	6.69	6.80	3	5.43
Guaranteed	2.47	8		6*	—	—
Found	2.76	8.39	10.15	6.88	1.33	5.56
Guaranteed	8	5	—	3*	—	—
Found	8.21	6.27	7.29	3.87	3.74	4.75
Guaranteed	3.30	5.75	—	10*	—	—
Found	3.95	6.76	7.19	10.22	2	5.05
Guaranteed	5.75	12	—	3.50	—	—
Found	4.65	12.60	14.36	2.64	3.33	7.09
Below guarantee	1.10			0.86		
Guaranteed	1.30	8	—	2	—	—
Found	1.62	9.21	10.83	2.84	0.54	2.13
Guaranteed	—	—	—	12.40	—	—
Found				12.75		

* Potash present in form of sulphate.

RESULTS OF ANALYSIS OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
H. J. Baker & Bro., New York City.	Lawn dressing.	White Plains.	4207
H. J. Baker & Bro., New York City.	Standard UNXLD.	Poughkeepsie	4241
H. J. Baker & Bro., New York City.	Vegetable, vine and tobacco manure.	Poughkeepsie	4242
H. J. Baker & Bro., New York City.	Victor.	Cutchogue.	4160
Berkshire Mills Fertilizer Co., Bridgeport, Conn.	Root fertilizer.	Mineola.	4114
Edwin Blakely, Otego, N. Y.	Buckwheat and oat special.	Otego.	4528
Bowker Fertilizer Co., Boston, Mass.	Acid phosphate.	Southampton.	4192
Bowker Fertilizer Co., Boston, Mass.	Ammoniated dissolved bone.	Southampton. Syracuse. Waverly.	4190 4287 5032
Bowker Fertilizer Co., Boston, Mass.	Bone and potash.	Warsaw.	4706
Bowker Fertilizer Co., Boston, Mass.	Bone and wood-ash.	Southampton	4187

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

	In 100 Pounds of Fertilizer.					
	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water soluble phosphoric acid.
Guaranteed	3.50	4.75	——	7	——	——
Found	4.08	4.55	5.03	8.67	2.58	3.55
Guaranteed	1.85	8	——	2.25	——	——
Found	2.01	8.66	10.67	2.99	1.11	5.33
Guaranteed	1.65	5.50	——	12	——	——
Found	1.68	6.69	7.71	12.57	0.78	4.38
Guaranteed	3.30	9	——	8*	——	——
Found	3.33	10.67	11.63	8.13	1.83	8.34
Guaranteed	2.50	8	——	6	——	——
Found	3.01	10.76	11.89	6.62	1.83	5.11
Guaranteed	——	10	——	2	——	——
Found		12.67	13.28	1.94		8.61
Guaranteed	——	11	——	——	——	——
Found		13.20	16.77			6.16
Guaranteed	1.50	8	——	2*	——	——
Found	1.87	10.60	12	2.30	0.54	6.60
Guaranteed	——	8	——	3	——	——
Found		8.68	12.34	3.38		3.80
Guaranteed	1.50	6	——	2	——	——
Found	1.71	6.28	12.34	1.93	0.79	

* Potash present in form of sulphate.

RESULTS OF ANALYSIS OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Bowker Fertilizer Co., Boston, Mass.	Celery special.	Middletown.	4990
Bowker Fertilizer Co., Boston, Mass.	Corn phosphate.	Brewster.	4214
Bowker Fertilizer Co., Boston, Mass.	Dissolved bone.	Mt. Morris. Collins.	4639 5074
Bowker Fertilizer Co., Boston, Mass.	Empire State bone and potash.	Almond. Collins.	4749 5073
Bowker Fertilizer Co., Boston, Mass.	Farm and garden phosphate.	Syracuse. Albany.	4277 4481
Bowker Fertilizer Co., Boston, Mass.	Food for flowers.	Watertown.	4892
Bowker Fertilizer Co., Boston, Mass.	Fresh ground bone.	Binghamton. Watertown.	4352 4893
Bowker Fertilizer Co., Boston, Mass.	Geneseo special.	Geneseo.	4645
Bowker Fertilizer Co., Boston, Mass.	Grape-belt and fruit special.	Milton.	4254

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

IN 100 POUNDS OF FERTILIZER.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	3.29	8	———	15*	———	———
Found	3	9.44	12.10	15	2.24	4.75
Below guarantee	0.29					
Guaranteed	1.50	8	———	2	———	———
Found	1.69	8	11.57	2.31	0.39	5.03
Guaranteed	———	12	———	———	———	———
Found		13.14	16.95			6.78
Guaranteed	———	8	———	3	———	———
Found		8.85	14.64	3.31		1.04
Guaranteed	1.50	8	———	2	———	———
Found	1.75	8.62	11.94	2.16	0.45	4.04
Guaranteed	2	4	———	2	———	———
Found	5.27	8.91	9.24	3.52	5.03	6.57
Guaranteed	2.25	5	18	———	———	———
Found	2.83	11.73	26.66		0.95	
Guaranteed	———	10	———	6*	———	———
Found		13.46	16.39	4.70		9.50
Below guarantee				1.30		
Guaranteed	0.75	7	———	5	———	———
Found	0.95	8.61	10.23	5.53	0.36	6.53

* Potash present in form of sulphate.

RESULTS OF ANALYSIS OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Bowker Fertilizer Co., Boston, Mass.	Hill and drill.	Syracuse. Geneseo. Monticello.	4278 4646 4994
Bowker Fertilizer Co., Boston, Mass.	Hop and potato phosphate with extra potash.	Milton. Hamilton. Fulton.	4255 4537 4934
Bowker Fertilizer Co., Boston, Mass.	Humphrey & Holdridge best grain phosphate.	Honeoye Falls. Lima.	4549 4552
Bowker Fertilizer Co., Boston, Mass.	Humphrey & Holdridge cabbage manure.	Honeoye Falls.	4551
Bowker Fertilizer Co., Boston, Mass.	Humphrey & Holdridge imp. cabbage manure.	Honeoye Falls. Lima.	4550 4553
Bowker Fertilizer Co., Boston, Mass.	Humphrey & Holdridge onion manure.	Honeoye Falls. Lima.	4557 4559
Bowker Fertilizer Co., Boston, Mass.	Humphrey & Holdridge standard phosphate.	Honeoye Falls.	4589
Bowker Fertilizer Co., Boston, Mass.	Lawn and garden dressing.	Binghamton.	4355
Bowker Fertilizer Co., Boston, Mass.	Lowe's bone and potash.	Leroy.	4673

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

IN 100 POUNDS OF FERTILIZER.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	2	8	———	2	———	———
Found	2.25	8.80	10.57	2.09	1.23	5.37
Guaranteed	0.75	8	———	5*	———	———
Found	1.07	9.80	11.66	6.07	0.38	6.65
Guaranteed	1	10	———	6	———	———
Found	1.39	11.97	13.88	5.95	0.41	8.01
Guaranteed	2.25	7	———	8	———	———
Found	2.32	9.83	10.97	8.11	0.61	7.23
Guaranteed	2.25	6	———	12	———	———
Found	2.41	6.80	9.12	12.36	0.58	4.83
Guaranteed	0.75	8	———	10	———	———
Found	1.03	8.38	9.22	10.42	0.82	5.83
Guaranteed	1	10	———	3	———	———
Found	1.25	11.30	13.25	2.77	0.04	7.62
Below guarantee				0.23		
Guaranteed	3	6	———	5	———	———
Found	4.04	7.30	10.20	5.18	3.87	0.31
Guaranteed	———	10	———	2	———	———
Found		9.36	13.37	2.25		2.93
Below guarantee		0.64				

* Potash present in form of sulphate.

RESULTS OF ANALYSIS OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Bowker Fertilizer Co., Boston, Mass.	Market garden.	Orient.	4151
Bowker Fertilizer Co., Boston, Mass.	Potash bone.	Milton.	4253
Bowker Fertilizer Co., Boston, Mass.	Potash or staple phosphate.	Hamilton. Leroy. Chester.	4536 4668 4976
Bowker Fertilizer Co., Boston, Mass.	Potato and vegetable manure.	Mt. Morris. Nichols.	4640 5026
Bowker Fertilizer Co., Boston, Mass.	Potato and vegetable phosphate.	Syracuse. Binghamton. Brewster.	4279 4357 4215
Bowker Fertilizer Co., Boston, Mass.	Soluble bone.	Warsaw. Almond. Penn Yan.	4705 4751 5157
Bowker Fertilizer Co., Boston, Mass.	Square brand bone and potash.	Albany.	4480
Bowker Fertilizer Co., Boston, Mass.	Special formula.	Fenton.	5061
Bowker Fertilizer Co., Boston, Mass.	Special grain fertilizer.	Penn Yan.	5149

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

IN 100 POUNDS OF FERTILIZER.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	2.25	6	———	10	———	———
Found	2.57	6.72	8.26	10.11	1.09	5.06
Guaranteed	0.75	5	———	2	———	———
Found	1	10.09	12.75	2.20	0.34	6.82
Guaranteed	0.75	8	———	3	———	———
Found	1.04	10.13	12.08	2.94	0.20	6.99
Guaranteed	2.50	8	———	4	———	———
Found	2.25	8.58	13.93	4.48	1.01	1.35
Below guarantee	0.25					
Guaranteed	1.50	8	———	2	———	———
Found	2.02	9.18	11.69	2.40	1.06	0.56
Guaranteed	———	14	———	———	———	———
Found		15.67	16.58			12.09
Guaranteed	1.50	6	12	2	———	———
Found	1.55	4.29	15.04	2.31	0.48	
Below guarantee		1.71				
Guaranteed	2	10	———	8	———	———
Found	2.31	11.94	11.94	8.38*	2.03	11.01
Guaranteed	1	10	———	4	———	———
Found	1.59	9.92	11.94	3.95	0.79	6.81

* Potash present in form of sulphate.

RESULTS OF ANALYSIS OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Bowker Fertilizer Co., Boston, Mass.	Special grain fertilizer.	Halls.	5233
Bowker Fertilizer Co., Boston, Mass.	Special potato fertilizer.	Southampton.	4189
Bowker Fertilizer Co., Boston, Mass.	Special sugar-beet fertilizer.	Binghamton.	4358
Bowker Fertilizer Co., Boston, Mass.	Stockbridge cabbage manure.	Syracuse.	4283
Bowker Fertilizer Co., Boston, Mass.	Stockbridge celery manure.	Oswego.	4925
Bowker Fertilizer Co., Boston, Mass.	Stockbridge complete manure for vines.	Syracuse.	4284
Bowker Fertilizer Co., Boston, Mass.	Stockbridge corn and grain manure.	Albany.	4482
Bowker Fertilizer Co., Boston, Mass.	Stockbridge pea and bean manure.	Syracuse.	4282
Bowker Fertilizer Co., Boston, Mass.	Stockbridge potato and vegetable manure.	Southampton. Syracuse. Binghamton.	4191 4281 4356
Bowker Fertilizer Co., Boston, Mass.	Stockbridge root manure.	Albany.	4483

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	0.75	8	——	4	——	——
Found	1.04	8.83	11.36	4.83	0.42	4.70
Guaranteed	2.25	8	——	4	——	——
Found	2.73	9.38	11.34	4.09	0.48	6.62
Guaranteed	1.50	8	——	5*	——	——
Found	1.33	6.68	9.07	8.15	0.29	4.19
Below guarantee		1.32				
Guaranteed	4	5	——	6	——	——
Found	4.98	6.93	10.13	6.11	2.96	5.06
Guaranteed	4.75	4	——	5.50	——	——
Found	4.89	7.24	9.24	6.64	2.75	4.64
Guaranteed	5	3	——	4	——	——
Found	4.98	7.43	10.41	5.88	2.50	4.66
Guaranteed	3	8	——	6*	——	——
Found	3.24	9.16	12.63	7.23	1.14	6.60
Guaranteed	2	6	——	6	——	——
Found	2.30	12.52	15.50	5.89	0.85	4.22
Guaranteed	3.20	5	——	10*	——	——
Found	3.16	6.88	8.34	11.38	1.51	4.63
Guaranteed	4	6	——	4*	——	——
Found	4.30	7.68	10.07	6.37	2.63	5.25

* Potash present in form of sulphate.

RESULTS OF ANALYSIS OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Bowker Fertilizer Co., Boston, Mass.	Superphosphate.	Binghamton.	4353
Bowker Fertilizer Co., Boston, Mass.	Superphosphate with potash.	Syracuse. Leroy. Ellicottville.	4285 4669 5107
Bowker Fertilizer Co., Boston, Mass.	Sure crop.	Syracuse. Mt. Morris. Warsaw.	4280 4638 4704
Bowker Fertilizer Co., Boston, Mass.	S. W. & C. grain special.	Geneseo.	4644
Bowker Fertilizer Co., Boston, Mass.	Tillotson & Howson's special.	Cazenovia.	4409
Bowker Fertilizer Co., Boston, Mass.	Tobacco grower.	Syracuse.	4286
Bowker Fertilizer Co., Boston, Mass.	Top dressing.	Southampton.	4188
Bowker Fertilizer Co., Boston, Mass.	Wilson's special.	Rushville.	5213
Bradley Fertilizer Co., Boston, Mass.	Alkaline bone with potash.	Wainscott. Leroy. Lowville.	4172 4681 4871
Bradley Fertilizer Co., Boston, Mass.	Ammoniated dissolved bone.	Tully. Lowville.	4289 4873

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

	In 100 Pounds of Fertilizer.					
	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed Found	———	13 14.87	——— 15.90	———	———	——— 10.86
Guaranteed Found	———	10 10.22	——— 16.71	1 1.23	———	——— 4.27
Guaranteed Found	0.75 0.92	8 9.89	——— 13.16	1 1.07	——— 0.17	——— 4.09
Guaranteed Found Below guarantee	1 1.43	10 12.33	——— 13.15	6* 5.23 0.77	——— 0.49	——— 9.16
Guaranteed Found	1.50 1.61	8 8.72	——— 12.10	2 3.88	——— 0.36	——— 6.31
Guaranteed Found	2.25 2.05	7 9.62	——— 10.57	4* 4.18	——— 0.60	——— 5.24
Guaranteed Found	4.75 4.67	4 7.26	——— 8.38	6 6.74	——— 2.76	——— 5.70
Guaranteed Found	1 1.32	10 11.09	——— 12.50	3 3.24	——— 0.80	——— 7.69
Guaranteed Found	———	11 11.04	——— 13.08	2.43 2.63	———	——— 4.46
Guaranteed Found	1.65 1.85	7 10.08	——— 11.58	1 1.22	——— 0.54	——— 7.32

* Potash present in form of sulphate.

RESULTS OF ANALYSIS OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand	Locality where sample was taken.	Station number.
Bradley Fertilizer Co., Boston, Mass.	Bean and potato fertilizer.	Tully. Unadilla. Leroy.	4292 4534 4683
Bradley Fertilizer Co., Boston, Mass.	Complete manure for potatoes and vegetables.	Jamaica. Halls.	4067 5232
Bradley Fertilizer Co., Boston, Mass.	Dissolved bone — Justice brand.	Almond. Lowville.	4754 4872
Bradley Fertilizer Co., Boston, Mass.	Dissolved bone with potash.	Dansville. Leroy.	4618 4686
Bradley Fertilizer Co., Boston, Mass.	English lawn fertilizer.	Penn Yan.	5151
Bradley Fertilizer Co., Boston, Mass.	Extra fine ground bone with potash.	Albany. Bliss.	4485 5110
Bradley Fertilizer Co., Boston, Mass.	Fruit and vine fertilizer.	Halls.	5231
Bradley Fertilizer Co., Boston, Mass.	Grain fertilizer.	Leroy.	4684
Bradley Fertilizer Co., Boston, Mass.	Farmers' new method fertilizer.	Tully. White Plains. Peoria.	4288 4210 5118

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

IN 100 POUNDS OF FERTILIZER.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	0.82	8	—	3.25	—	—
Found	1.47	8.69	10.57	3.74	0.45	2.99
Guaranteed	3.30	8	—	7	—	—
Found	3.28	8.31	9.91	6.66	3.07	4.56
Below guarantee				0.34		
Guaranteed	—	12	—	—	—	—
Found		12.05	14.34			7.97
Guaranteed	0.82	8	—	2.15	—	—
Found	0.97	8.86	10.28	2.30	0.30	5.70
Guaranteed	4.95	5	—	2.50*	—	—
Found	5.35	4.88	6.13	3.22	5.27	0.79
Guaranteed	1.85	6	—	2	—	—
Found	1.99	7.92	15.43	2.09	0.56	
Guaranteed	2	7	—	5.40	—	—
Found	2.18	9.53	11.60	4.11	0.79	5.46
Below guarantee				1.29		
Guaranteed	2.06	11	—	1.08	—	—
Found	2.34	10.59	15.71	1.20	0	2.65
Below Guarantee		0.41				
Guaranteed	0.82	8	—	2.15	—	—
Found	1.22	9.04	10.32	2.36	0.42	6.76

* Potash present in form of sulphate.

RESULTS OF ANALYSIS OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Bradley Fertilizer Co., Boston, Mass.	Niagara.	Tully. Dansville. Haverstraw.	4290 4619 4965
Bradley Fertilizer Co., Boston, Mass.	Patent superphosphate of lime.	Oneonta. White Plains. Leroy.	4503 4211 4682
Bradley Fertilizer Co., Boston, Mass.	Potato fertilizer.	Tully. Albany. Gainesville.	4291 4486 4734
Bradley Fertilizer Co., Boston, Mass.	Sea-fowl guano.	Dansville. Leroy. Lowville.	4620 4685 4870
Bradley Fertilizer Co., of Philadelphia, Pa.	Extra high-grade potato guano.	Hyde Park.	4125
Bradley Fertilizer Co., of Philadelphia, Pa.	Market garden.	Hyde Park.	4122
Bradley Fertilizer Co., of Philadelphia, Pa.	Potato guano No. 1.	Hyde Park.	4124
Bradley Fertilizer Co., of Philadelphia, Pa.	Special for peas.	Hyde Park.	4123
Brumfield & Foster, Colora, Md.	Ammoniated bone phosphate.	Sherburne.	4403
Brumfield & Foster, Colora, Md.	Hard times ammoniated phosphate.	Sherburne.	4405

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

IN 100 POUNDS OF FERTILIZER.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	0.82	7	——	1.08	——	——
Found	1.08	7.48	10.01	1.24	0.41	3.21
Guaranteed	2.06	8	——	1.50	——	——
Found	2.12	9.17	12.12	1.66	0.73	5.72
Guaranteed	2.06	9	——	3.25	——	——
Found	1.94	9.73	10.39	3.25	0.67	7.33
Guaranteed	2.06	8	——	1.50	——	——
Found	1.94	9.43	13.25	1.70	0.76	3.96
Guaranteed	3.25	6	——	9	——	——
Found	3.42	8.56	9.61	9.84	1.64	3.68
Guaranteed	3.25	8	——	6	——	——
Found	3.78	9.27	10.42	6.22	1.85	3.87
Guaranteed	2.50	7.	——	7*	——	——
Found	2.80	9.21	10.47	7.28	1.05	4.72
Guaranteed	1.85	9	——	2.50	——	——
Found	2.06	9.58	11.34	3.38	0.79	2
Guaranteed	1.50	9	——	2	——	——
Found	1.39	9.58	11.99	2.07	0.48	0.35
Guaranteed	0.80	10	——	1	——	——
Found	0.82	10.27	12.87	1.12	0.46	0.47

* Potash present in form of sulphate.

RESULTS OF ANALYSIS OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
J. P. Butts, Oneonta, N. Y.	Hustler.	Oneonta.	4502
J. P. Butts, Oneonta, N. Y.	Potato manure No. 1.	Oneonta.	4500
J. P. Butts, Oneonta, N. Y.	Standard No. 1.	Oneonta.	4501
Campbell & Pulver, Italy Hill, N. Y.	Dissolved bone.	Italy Hill.	5196
Campbell & Pulver, Italy Hill, N. Y.	Free-silver phosphate.	Italy Hill.	5200
Campbell & Pulver, Italy Hill, N. Y.	Gold standard phosphate.	Italy Hill.	5201
Campbell & Pulver, Italy Hill, N. Y.	N. Y. standard phosphate.	Italy Hill.	5199
Campbell & Pulver, Italy Hill, N. Y.	Prattsburg special.	Italy Hill.	5197
Campbell & Pulver, Italy Hill, N. Y.	Thirteen and three.	Italy Hill.	5198
Chemical Co., of Canton, Baltimore, Md.	Ontario brand.	Penn Yan.	4946

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

IN 100 POUNDS OF FERTILIZER.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	0.82	8	——	4	——	——
Found	1.30	7.82	10.02	4.86	0.17	5.89
Guaranteed	2.47	7	——	8	——	——
Found	2.80	8.03	9.95	8.12	0.65	4.31
Guaranteed	1.65	9	——	2	——	——
Found	1.51	9.58	12.83	2.41	0.67	4.69
Guaranteed	——	16	——	——	——	——
Found		17.03	18.44			12.03
Guaranteed	0.82	14	——	2	——	——
Found	1.13	14.28	14.68	2.20	0.37	11.09
Guaranteed	0.82	8	——	4	——	——
Found	0.81	8.40	9.93	4.57	0.44	4.77
Guaranteed	2.47	7	——	8	——	——
Found	2.13	8.25	9.81	7.95	0.98	5.24
Below guarantee	0.34					
Guaranteed	0.82	10	——	8	——	——
Found	0.92	10.43	11.60	8.07	0.42	7.75
Guaranteed	——	13	——	3	——	——
Found		13.17	13.99	3.54		10.13
Guaranteed	0.80	8	——	4	——	——
Found	0.81	8.47	10.95	3.30	0.23	2.14
Below guarantee				0.70		

RESULTS OF ANALYSIS OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Chemical Co., of Canton, Baltimore, M. D.	Potato manure.	Oneida.	4425
Clark's Cove Fertilizer Co., New York City.	Atlas bone phosphate.	South Lima. Clinton.	4604 4855
Clark's Cove Fertilizer Co., New York City.	Bay State fertilizer.	North Boston.	4840
Clark's Cove Fertilizer Co., New York City.	Defiance complete manure.	East Avon. Clinton. SpringValley.	4555 4852 4970
Clark's Cove Fertilizer Co., New York City.	Great planet "A" brand.	Flatlands.	4200
Clark's Cove Fertilizer Co., New York City.	Great planet "B" brand.	Flatlands.	4201
Clark's Cove Fertilizer Co., New York City.	King Philip alkaline guano.	East Avon. Pulaski. SpringValley.	4554 4922 4971
Clark's Cove Fertilizer Co., New York City.	Muriate of potash.	South Lima.	4605
Clark's Cove Fertilizer Co., New York City.	Nitrate of soda.	South Lima.	4606
Clark's Cove Fertilizer Co., New York City.	Potato and hop grower.	Clinton. Pulaski.	4854 4921

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	0.80	8	——	2.43	——	——
Found	0.96	8.41	10.43	2.36	0.17	3.36
Guaranteed	——	13	——	——	——	——
Found		14.17	16.07			10.71
Guaranteed	2.50	9	——	2	——	——
Found	2.82	9.76	12.56	2.10	0.94	5.48
Guaranteed	0.82	6	——	2	——	——
Found	1.06	8.60	10.13	2.28	0.50	4.26
Guaranteed	3.30	8	——	7	——	——
Found	3.27	9.06	11.16	7.55	2.01	3.61
Guaranteed	4.94	5	——	7	——	——
Found	4.80	7.66	9.39	6.88	2.55	2.94
Guaranteed	1.25	6	——	3	——	——
Found	1.26	8.11	9.78	2.97	0.62	4.40
Guaranteed	——	——	——	50.40	——	——
Found				49.74		
Below guarantee				0.66		
Guaranteed	15.40	——	——	——	——	——
Found	15.61				15.61	
Guaranteed	1.23	6	——	5	——	——
Found	1.58	7.17	9.33	5.04	0.77	2.16

RESULTS OF ANALYSIS OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Cleveland Dryer Co., Cleveland, Ohio.	Dissolved bone phosphate.	Jamestown.	5096
Cleveland Dryer Co., Cleveland, Ohio.	For all crops.	Sherburne.	4396
Cleveland Dryer Co., Cleveland, Ohio.	High-grade corn manure.	Sherburne.	4395
Cleveland Dryer Co., Cleveland, Ohio.	Ohio seed maker with potash.	North Collins. Jamestown.	5046 5095
Cleveland Dryer Co., Cleveland, Ohio.	Phospho bone.	Jamestown.	5097
Cleveland Dryer Co., Cleveland, Ohio.	Pioneer.	Sherburne.	4394
Cleveland Dryer Co., Cleveland, Ohio.	Potato phosphate.	Sherburne.	4397
Cleveland Dryer Co., Cleveland, Ohio.	Square bone.	Hamburg.	4845
Cleveland Dryer Co., Cleveland, Ohio.	Superior bone.	Hamburg. North Collins.	4846 5044

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

	In 100 Pounds of Fertilizer.					
	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	—	10	—	—	—	—
Found		9.89	14.03			6
Below guarantee						
Guaranteed	1.03	8	—	2	—	—
Found	1.06	8.09	10.20	2.34	0.34	5.80
Guaranteed	3.12	8	—	7	—	—
Found	3.30	8.60	10.51	6.96	1.23	5.61
Guaranteed	1.23	10.	—	2.16	—	—
Found	1.14	9.98	14.60	2.17	0.74	4.41
Guaranteed	2.60	10	—	1.08*	—	—
Found	0.96	9.42	13.61	0.59	0.22	5.25
Below guarantee	1.64	0.58		0.49		
Guaranteed	0.82	7	—	1	—	—
Found	1.08	7.27	10.21	1.17	0.40	2.97
Guaranteed	2.05	8	—	—	—	—
Found	2.08	8.18	12.37	3.18	0.64	4.40
Guaranteed	2.05	—	20	—	—	—
Found	2.70	—	16.46		1.82	
Below guarantee			3.54			
Guaranteed	3.39	—	22	—	—	—
Found	3.17		21.32		0.78	
Below guarantee			0.68			

* Potash present in form of sulphate.

RESULTS OF ANALYSIS OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
E. Frank Coe Co., New York City.	Alkaline bone.	Orient. Mt. Morris. Ellicottville.	4152 4635 5102
E. Frank Coe Co., New York City.	Celebrated special potato fertilizer.	Portchester.	4213
E. Frank Coe Co., New York City.	Columbian brand ammoniated bone superphosphate.	Liberty. Rushville.	4998 5208
E. Frank Coe Co., New York City.	Columbian corn fertilizer.	Wayland. Parish. Monticello.	4614 4916 4996
E. Frank Coe Co., New York City.	Columbian potato fertilizer.	Parish. Ellicottville.	4917 5104
E. Frank Coe Co., New York City.	Dissolved bone and potash.	Homer. Castile.	4300 4725
E. Frank Coe Co., New York City.	Excelsior guano.	Jamaica.	4071
E. Frank Coe Co., New York City.	Excelsior potato.	Hollis. East Avon. Prattsburg.	4082 4653 5204
E. Frank Coe Co., New York City.	Gold brand excelsior guano.	East Avon.	4652

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	1.20	9	——	1.85*	——	——
Found	1.46	9.97	12.89	1.79	0.75	7.22
Guaranteed	1.65	8	——	4*	——	——
Found	1.79	8.45	11.58	3.74	1.09	6.80
Below guarantee				0.26		
Guaranteed	1	9	——	1.85*	——	——
Found	1.36	9.63	13.01	3.13	0.80	7.05
Guaranteed	1.20	9	——	1.85*	——	——
Found	1.45	10.04	13.31	2.38	0.71	7.38
Guaranteed	1.20	9	——	1.85*	——	——
Found	1.51	9.57	13.20	2.57	0.64	7.25
Guaranteed	——	12	——	2.50*	——	——
Found		12.79	14.04	3.53		8.22
Guaranteed	3.50	9	——	3.40*	——	——
Found	3.43	8.84	11.10	3.94	1.25	6.92
Guaranteed	2.50	8	——	8*	——	——
Found	2.69	7.56	9.41	8.44	1.91	5.86
Below guarantee		0.44				
Guaranteed	2.50	8	——	6*	——	——
Found	2.62	8.60	11.67	5.19	1.62	6.58
Below guarantee				0.81		

* Potash present in form of sulphate.

RESULTS OF ANALYSIS OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
E. Frank Coe Co., New York City.	Grain and grass fertilizer.	Castile. West Almond	4723 4748
E. Frank Coe Co., New York City.	Ground bone and potash.	White Plains. East Avon.	4205 4656
E. Frank Coe Co., New York City.	High-grade ammoniated bone.	East Avon.	4651
E. Frank Coe Co., New York City.	High-grade soluble bone.	Wayland. West Almond Friend.	4615 4747 5148
E. Frank Coe Co., New York City.	High-grade special corn fertilizer.	Newburg.	4245
E. Frank Coe Co., New York City.	Kainit.	Castile.	4727
E. Frank Coe Co., New York City.	Long Islander market garden special.	Jamaica.	4106
E. Frank Coe Co., New York City.	Matchless grain fertilizer.	Rushville.	5209
E. Frank Coe Co., New York City.	New Englander special potato.	Gainesville.	4737

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

IN 100 POUNDS OF FERTILIZER.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	0.40	10.50	———	1.25*	———	———
Found	0.50	10.54	14.62	1.68	0	6.17
Guaranteed	2.05	———	14	2.50	———	———
Found	2.09		19.74	2.64	1.09	
Guaranteed	2	9	———	1.85*	———	———
Found	2.20	9.59	12.01	2.21	1.07	7.39
Guaranteed	———	13	———	———	———	———
Found		13.55	15.97			10.27
Guaranteed	1.75	9	———	3*	———	———
Found	1.85	8.68	11.72	3.54	0.97	6.90
Below guarantee		0.22				
Guaranteed	———	———	———	———	———	———
Found				11.94		
Guaranteed	3.50	9	———	6*	———	———
Found	3.16	8.66	10.04	7.29	1.93	6.96
Below guarantee	0.34	0.34				
Guaranteed	0.65	11	———	1*	———	———
Found	1.12	10.95	13.56	1.76	0.38	7.42
Guaranteed	0.80	9	———	2.17*	———	———
Found	1.07	10.50	13.68	1.97	0.53	7.20

* Potash present in form of sulphate.

RESULTS OF ANALYSIS OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
E. Frank Coe Co., New York City.	Original ammoniated dissolved bone.	Dresden.	5159
E. Frank Coe Co., New York City.	Prize brand grain fertilizer.	Dresden.	5160
E. Frank Coe Co., New York City.	Pure ground bone.	East Avon.	4655
E. Frank Coe Co., New York City.	Red brand excelsior guano.	Jamaica.	4070
E. Frank Coe Co., New York City.	Special cabbage manure.	Hollis.	4083
E. Frank Coe Co., New York City.	Special celery manure.	Middletown.	4991
E. Frank Coe Co., New York City.	Standard ammoniated bone superphosphate.	Portchester. East Avon. Port Jervis.	4212 4650 4992
E. Frank Coe Co., New York City.	Sulphate of potash.	Castile.	4726
E. Frank Coe Co., New York City.	Tobacco and onion fertilizer.	East Avon.	4654

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	1.25	10	——	2.25*	——	——
Found	1.56	9.97	12.38	2.49	0.99	7.29
Guaranteed	0.40	10.50	——	1.25*	——	——
Found	0.60	11.57	15.09	1.14	0.10	6.18
Guaranteed	2.50	——	18.40	——	——	——
Found	3.05		18.72		0.06	
Guaranteed	3.50	9	——	6*	——	——
Found	3.35	8.86	10.13	6.83	2.08	6.81
Guaranteed	3.50	9	——	6*	——	——
Found	3.41	8.75	10.27	6.68	2.15	6.76
Below guarantee		0.25				
Guaranteed	3.29	8	——	15*	——	——
Found	3.41	7.10	8.45	14.86	2.71	5.07
Below guarantee		0.90				
Guaranteed	1.75	8	——	1.35*	——	——
Found	7.82	9.34	12.45	1.93	1.03	7.04
Guaranteed	——	——	——	——	——	——
Found				30.44*		
Guaranteed	3.29	6	——	8*	——	——
Found	3.82	7.98	10.05	6.22	2.22	6.43
Below guarantee				1.78		

* Potash present in form of sulphate.

RESULTS OF ANALYSIS OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
E. Frank Coe Co., New York City.	Vegetable and vine fertilizer.	East Avon. Castile. Rushville.	4649 4724 5207
E. Frank Coe Co., New York City.	XXV ammoniated bone superphosphate.	Mt. Morris. Liberty. Rushville.	4636 4997 5206
Peter Cooper Glue Factory, New York City.	Pure bone dust No. 2.	Arlington.	4238
T. L. Corwin & Son, Marathon, N. Y.	A 1 potato special.	Marathon.	4319
T. L. Corwin & Son, Marathon, N. Y.	No. 2 grain and vine.	Marathon.	4321
T. L. Corwin & Son, Marathon, N. Y.	No. 3 leader brand.	Marathon.	4322
T. L. Corwin & Son, Marathon, N. Y.	No. 4 imperial fertilizer.	Marathon.	4320
John Conklin & Son, Penn Yan, N. Y.	Yates grain special.	Penn Yan.	5156

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

IN 100 POUNDS OF FERTILIZER.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	2	8	——	6*	——	——
Found	2.31	8.67	10.81	5.66	.1	6.53
Below guarantee				0.34		
Guaranteed	0.80	8	——	1.50*	——	——
Found	1.26	10.99	13.88	1.50	0.26	7.27
Guaranteed	0.87	——	26.67	——	——	——
Found	1.52		28.83		0.38	
Guaranteed	2.46	7	——	8	——	——
Found	2.41	8.65	10.67	7.71	0.23	7.10
Below guarantee				0.29		
Guaranteed	1.85	9	——	4	——	——
Found	1.57	10.03	10.97	4.88	0.14	6.99
Below guarantee	0.28					
Guaranteed	1.23	10	——	3	——	——
Found	1.22	11.24	12.45	2.99	0.30	7.54
Guaranteed	0.82	9	——	2	——	——
Found	0.82	9.56	10.69	2.37	0.16	5.66
Guaranteed	1.25	10	——	8	——	——
Found	1.03	9.30	12.27	8.20	0.49	3.18
Below guarantee		0.70				

* Potash present in form of sulphate.

RESULTS OF ANALYSIS OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Acid fertilizer.	Perry.	4718
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Ammoniated bone superphosphate.	Clinton. Holland.	4542 4808
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Ammoniated wheat and corn phosphate.	Norwich. Holland. Brocton.	4379 4809 5133
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Bone and potash No. 1.	Perry.	4719
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Brainerd & Beaumont's special.	Gainesville.	4738
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Complete manure.	Perry.	4720
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Conklin's soluble bone.	Penn Yan.	5158
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Dissolved bone phosphate.	Gainesville. Gowanda. Prattsburg.	4736 5086 5203
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Erie phosphate.	Caledonia. Machias Junction. Oswego Cent.	4662 4796 4927

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	——	12	——	——	——	——
Found		11.81	12.92			8.07
Guaranteed	2.90	10	——	1.08	——	——
Found	3	10.65	11.96	1.25	0.35	6.50
Guaranteed	2	10	——	1.60	——	——
Found	2.30	10.27	11.20	1.79	0.68	7.50
Guaranteed	——	10	——	8	——	——
Found		10.12	10.55	9.34		6.95
Guaranteed	0.82	4	——	8	——	——
Found	1.09	4.26	5.40	8.53	0.05	1.54
Guaranteed	0.82	8	——	4	——	——
Found	1.04	8.09	9.46	5.50	0.29	5.20
Guaranteed	——	14	——	——	——	——
Found		13.75	15.98			9.08
Below guarantee		0.25				
Guaranteed	——	14	——	——	——	——
Found		14.45	15.15			8.26
Guaranteed	——	11	——	——	——	——
Found		11.54	12.69			7.83

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	General crop phosphate.	Norwich. Caledonia. Owego.	4377 4661 5009
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Grenell's corn grower.	Pierrepont Manor.	4904
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Grenell's special.	Pierrepont Manor.	4903
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Ground bone meal.	Rushville.	5215
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	High-grade cereal guano.	Gowanda.	5085
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Johnson's special.	Geneseo.	4647
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Market garden special.	Bay Side.	4102
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	New rival ammoniated superphosphate.	Jamaica. Norwich. Perry.	4063 4378 4721
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	New York special.	Kanona.	5205

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

IN 100 POUNDS OF FERTILIZER.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	0.82	7	——	1.08	——	——
Found	1.15	7.48	9.40	1.15	0.14	3.27
Guaranteed	0.82	7	——	2.16	——	——
Found	1	10.03	10.69	2.26	0.06	6.72
Guaranteed	0.82	10	——	3*	——	——
Found	1.06	11.99	12.70	3.38	0.12	8.48
Guaranteed	2	——	25	——	——	——
Found	2.32		27.13		0.60	
Guaranteed	0.82	8	——	2	——	——
Found	1	8.03	8.33	2.22	0.48	4.63
Guaranteed	——	10	——	7	——	——
Found		10	10.70	5.57		6.95
Below guarantee				1.43		
Guaranteed	3.70	8	——	8	——	——
Found	4	7.95	10.18	9.14	0.92	5.02
Guaranteed	1.23	10	——	1.60	——	——
Found	1.16	10.39	11.86	1.83	0.41	6.95
Guaranteed	——	10	——	8	——	——
Found		11.19	12.93	7.06		6.45
Below guarantee				0.94		

* Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Penfield Milling Co's corn and oats.	Delhi.	5005
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Potato, hop and tobacco phosphate.	Fayetteville. Owego. Brocton.	4406 5012 5134
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Practical ammoniated superphosphate.	Cazenovia. Gainesville. Phœnix.	4412 4735 4938
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Pure ground bone.	Holland. Rushville.	4811 5214
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Royal phosphate.	Clinton.	4540
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	South Lima onion and celery grower.	South Lima.	4586
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Special cabbage fertilizer.	Homer.	4298
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Special potato fertilizer.	Holland. Oswego Cent.	4810 4928
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Superior rye and oats.	Sharon Stat'n Lishaskill.	4221 4476

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

	In 100 Pounds of Fertilizer.					
	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	1.64	9	—	2	—	—
Found	1.59	11.44	11.92	2.12	0.20	7.69
Guaranteed	2	10	—	3.25	—	—
Found	2.45	10.35	11.02	2.98	0.90	7.05
Below guarantee				0.27		
Guaranteed	0.82	8	—	1.08	—	—
Found	1.08	8.07	12.71	1.50	0.46	5.11
Guaranteed	2.90	—	25	—	—	—
Found	2.74		24.63		0.38	
Guaranteed	2	10	—	2	—	—
Found	1.93	12.76	13.47	1.81	0.23	9.18
Guaranteed	2.87	8	—	12	—	—
Found	3.15	8.38	10.66	12.45	0.34	5.43
Guaranteed	2.46	8	—	6	—	—
Found	3	8.25	9.55	6.61	0.84	4.70
Guaranteed	3.70	8	—	5.40	—	—
Found	4	9.18	10.86	6.04	0.89	6.21
Guaranteed	0.82	8	—	2	—	—
Found	0.99	8.11	8.76	2.12	0.47	5.26

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Thompson's ammoniated dissolved bone phosphate.	Boonville.	4860
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Thompson's high-grade fertilizer.	Boonville.	4861
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Thompson's special potato manure.	Boonville.	4858
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Thompson's standard fertilizer.	Boonville.	4859
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Tripp's celery and onion special No. 1.	Lima.	4560
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Tripp's celery and onion special No. 2.	Avon.	4580
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Tripp's celery and onion special No. 3.	Lima. Avon.	4559 4599
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Tripp's celery and onion special No. 4.	Avon.	4600
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Universal grain grower.	Adams. Owego. Brocton.	4902 5010 5135

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

IN 100 POUNDS OF FERTILIZER.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	2	9	——	2.50	——	——
Found	2	8.90	9.84	2.35	0.52	6
Guaranteed	2.46	10	——	10	——	——
Found	2.91	10.07	10.42	9.07	1.52	7.73
Below guarantee				0.93		
Guaranteed	1.64	8	——	4	——	——
Found	2.15	7.97	8.93	3.90	0.63	6.02
Guaranteed	0.82	8	——	2	——	——
Found	1.37	8.30	8.81	2.96	0.36	5.20
Guaranteed	0.82	7	——	12	——	——
Found	0.98	8.84	9.22	12.19	0.19	6.16
Guaranteed	0.82	7	——	15	——	——
Found	1	9.63	9.96	12.08	0.12	6.77
Below guarantee				2.92		
Guaranteed	1.64	7	——	15	——	——
Found	1.81	8.81	9.15	15.22	0.60	6.14
Guaranteed	1.23	8	——	12	——	——
Found	1.81	8.91	9.31	12.66	0.19	6.94
Guaranteed	0.82	7	——	2.70	——	——
Found	1.15	7.52	9.47	2.98	0.51	4.63

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand	Locality where sample was taken.	Station number.
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Vegetable bone superphosphate.	Cazenovia.	4411
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Vegetable and potato special.	Mineola.	4115
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Vernon's onion special.	Florida.	4980
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	W. & H. special potato manure.	Riverhead.	4128
Cuba Fertilizer Co., Cuba, N. Y.	Buckwheat special.	Almond. Cuba.	4758 4772
Cuba Fertilizer Co., Cuba, N. Y.	Cereal special.	Cuba.	4773
Cuba Fertilizer Co., Cuba, N. Y.	Competition.	Fredonia. Corning.	5127 5184
Cuba Fertilizer Co., Cuba, N. Y.	Genesee Valley special.	Cuba.	4771
Cuba Fertilizer Co., Cuba, N. Y.	Hustler.	Cuba. Fredonia.	4775 5126

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	5	6	———	5.94	———	———
Found	5.17	5.66	6.20	6.17	1.56	3.94
Below guarantee		0.34				
Guaranteed	2.47	7	———	7	———	———
Found	2.61	7.72	8.68	7.84	1.74	4.49
Guaranteed	2	9	———	3.10	———	———
Found	2.24	10.12	11.03	3.29	0.93	6.40
Guaranteed	2.46	6	———	6	———	———
Found	2.64	6.44	8.06	6.04	0.14	3.49
Guaranteed	———	14	———	———	———	———
Found		15.35	15.94			10.81
Guaranteed	———	14	———	———	———	———
Found		15.52	16.25			10.34
Guaranteed	0.83	8	———	1	———	———
Found	0.87	9.42	11.02	1.46	0.39	6.43
Guaranteed	———	10	———	8	———	———
Found		11.11	11.62	7.75		8.06
Below guarantee				0.25		
Guaranteed	0.83	8	———	4	———	———
Found	0.91	8.50	10.06	4.16	0.38	4.83

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand	Locality where sample was taken.	Station number.
Cuba Fertilizer Co., Cuba, N. Y.	Potato and corn manure.	Almond. Cuba.	4756 4774
Cuba Fertilizer Co., Cuba, N. Y.	Standard.	Almond.	4757
Cuba Fertilizer Co., Cuba, N. Y.	Standard potato manure.	Corning.	5243
Cuba Fertilizer Co., Cuba, N. Y.	Sure crop.	Cuba.	4776
Cumberland Bone Phosphate Co., Portland, Me.	Bone and potash.	Rome. Schenectady.	4441 4472
Cumberland Bone Phosphate Co., Portland, Me.	Concentrated fertilizer.	Franklin Iron Works.	4851
Cumberland Bone Phosphate Co., Portland, Me.	Corn fertilizer.	Rome.	4439
Cumberland Bone Phosphate Co., Portland, Me.	Dissolved bone phosphate.	Sherburne. Schenectady. Big Tree.	4402 4473 5041
Cumberland Bone Phosphate Co., Portland, Me.	Fruit and vine.	Whitney Pt. Schenectady.	4329 4470

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	2.47	7	——	8	——	——
Found	2.53	7.85	9.31	7.73	1.03	4.70
Below guarantee				0.27		
Guaranteed	1.23	10	——	3	——	——
Found	1.34	9.22	11.51	2.80	0.49	6.21
Below guarantee		0.78				
Guaranteed	2.47	7	——	8	——	——
Found	2.69	7.33	8.72	8.73	0.77	5.12
Guaranteed	0.83	8	——	1	——	——
Found	0.88	9.33	10.92	2.22	0.54	5.90
Guaranteed	——	8	——	2.50	——	——
Found		8.92	11.21	2.64		
Guaranteed	3.30	8	——	7	——	——
Found	3.25	8.36	10.68	7.29	1.74	3.26
Guaranteed	1.65	8	——	2	——	——
Found	1.81	8.91	11.18	2.55	0.55	5.32
Guaranteed	——	10	——	——	——	——
Found		11.05	12.59			7.99
Guaranteed	0.82	4	——	8	——	——
Found	1.28	4.81	9.97	8.85	0.41	2.55

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Cumberland Bone Phosphate Co., Portland, Me.	Guano.	Whitney Pt. Pulaski. Monticello.	4331 4920 4994
Cumberland Bone Phosphate Co., Portland, Me.	Kainit.	Big Tree.	5042
Cumberland Bone Phosphate Co., Portland, Me.	Potato fertilizer.	Whitney Pt.	4330
Cumberland Bone Phosphate Co., Portland, Me.	Prepared blood.	Big Tree.	5040
Cumberland Bone Phosphate Co., Portland, Me.	Seeding down fertilizer.	Whitney Pt. Monticello.	4332 4995
Cumberland Bone Phosphate Co., Portland, Me.	Superphosphate.	Rome. Schenectady.	4440 4471
L. B. Darling Fertilizer Co., Pawtucket, R. I.	"A" brand.	Greenport.	4140
L. B. Darling Fertilizer Co., Pawtucket, R. I.	"B" brand.	Greenport.	4141
L. B. Darling Fertilizer Co., Pawtucket, R. I.	Blood, bone and potash.	Greenport.	4143

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

	In 100 Pounds of Fertilizer.					
	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	1.03	8	——	2	——	——
Found	1.19	9.12	10.76	2.32	0.13	7.06
Guaranteed	——	——	——	12.40	——	——
Found				17.36		
Guaranteed	2	9	——	3	——	——
Found	2.16	8.94	12.05	2.95	0.58	5.17
Guaranteed	8.20	——	——	——	——	——
Found	7.32				2.18	
Below guarantee	0.88					
Guaranteed	0.82	7	——	1	——	——
Found	0.83	7.73	10.06	1.30	0.47	3.18
Guaranteed	2.06	8	——	2	——	——
Found	2.18	9.60	12.01	2.07	0.93	5.10
Guaranteed	2.88	9	——	7	——	——
Found	3.83	9.34	10.90	7.44	1.69	4.09
Guaranteed	3.71	6	——	5	——	——
Found	4.32	8.80	10.34	5.75	1.96	3.59
Guaranteed	4.12	7	——	7	——	——
Found	3.88	8.95	9.40	7.55	2.15	5.52
Below guarantee	0.24					

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
L. B. Darling Fertilizer Co., Pawtucket, R. I.	"C" brand.	Greenport.	4142
Detrick Fertilizer and Chemical Co., Baltimore, Md.	W. E. Lowe's special.	Geneseo.	4643
Louis F. Detrick, Baltimore, Md.	Bone and potash mixture.	Brocton.	5139
Louis F. Detrick, Baltimore, Md.	"K.K.K." Kangaroo Komplete Kompound.	Brocton.	5138
Louis F. Detrick, Baltimore, Md.	Wooldridge's extra acid phosphate.	Brocton.	5140
C. A. Dryer, South Lima, N. Y.	C. A. D. special No. 4.	South Lima.	4585
Edward Dwyer, Livonia, N. Y.	"A" brand.	Livonia.	4578
Edward Dwyer, Livonia, N. Y.	Black diamond.	Livonia.	4579
R. D. Eaton, Norwich, N. Y.	Ammoniated bone phosphate.	Norwich.	4374

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	4	6	——	10	——	——
Found	4.39	7.49	8.76	10.10	2.01	2.84
Guaranteed	——	10	——	6	——	——
Found		10.02	13.38	5.15		3.08
Below guarantee				0.85		
Guaranteed	——	10	——	2.25	——	——
Found		10.96	12.79	2.38		7.52
Guaranteed	1.65	8	——	3	——	——
Found	1.70	9.47	11.75	3.09	0.75	6.91
Guaranteed	——	14	——	——	——	——
Found		15.33	15.90			12.41
Guaranteed	1	8	——	12	——	——
Found	0.92	8.54	11.12	11.72	0.24	5.94
Below guarantee				0.28		
Guaranteed	0.82	8	——	4	——	——
Found	0.75	8.61	9.61	4.53	0.43	4.97
Guaranteed	1.65	10	——	5	——	——
Found	1.47	9.56	10.78	5.97	0.38	6.86
Below guarantee		0.44				
Guaranteed	2.06	8	——	3	——	——
Found	1.82	7.85	9.02	3.68	0.94	6.09
Below guarantee	0.24					

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER	Trade name or brand.	Locality where sample was taken.	Station number.
R. D. Eaton, Norwich, N. Y.	Corn, oats and grass special.	Norwich. Earlville.	4376 4382
R. D. Eaton, Norwich, N. Y.	Special hop and potato.	Norwich.	4373
R. D. Eaton, Norwich, N. Y.	Special potato manure.	Norwich. Earlville.	4375 4381
Eureka Fertilizer Co., Avon, N. Y.	Eureka.	Avon.	4597
Farmers' Fertilizer Co., Syracuse, N. Y.	Fair and square.	Franklinville.	4793
Farmers' Fertilizer Co., Syracuse, N. Y.	Phœnix.	Syracuse. Earlville. Franklinville.	4310 4380 4794
Farmers' Fertilizer Co., Syracuse, N. Y.	Soluble bone.	Leroy.	4677
Farmers' Fertilizer Co., Syracuse, N. Y.	Standard bone phosphate.	Syracuse.	4311
Farmers' Fertilizer Co., Syracuse, N. Y.	Standard bone phosphate, special formula.	South Lima. Jamestown.	4598 5094

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

IN 100 POUNDS OF FERTILIZER.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	1.03	8	——	3	——	——
Found	1.10	9.15	10.42	3.40	0.27	4.88
Guaranteed	0.82	8	——	6	——	——
Found	0.63	7.95	9.59	5.82	0.29	4.84
Guaranteed	0.82	8	——	4	——	——
Found	0.82	8.58	10.02	4.42	0.34	5.30
Guaranteed	——	10	——	3.25	——	——
Found		11.26	12.88	4.96		7.39
Guaranteed	2.47	7	——	0.54	——	——
Found	2	7.17	11.53	0.44	0.29	2.48
Below guarantee	0.47					
Guaranteed	1.23	5	——	1.60	——	——
Found	0.83	5.45	7.27	2.16	0.11	3.10
Below guarantee	0.40					
Guaranteed	——	8	——	2.16	——	——
Found		7.46	8.45	2.63		1.64
Below guarantee		0.54				
Guaranteed	0.82	9	——	3.24	——	——
Found •	0.62	10.78	12.10	3.74	0	6.44
Guaranteed	0.82	8	——	2.16	——	——
Found	0.88	7.57	10.15	2.60	0.04	2.87
Below guarantee		0.43				

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Farmers' Fertilizer Co., Syracuse, N. Y.	Standard special formula.	Franklinville.	4792
Farmers' Fertilizer Co., Syracuse, N. Y.	Club and grange formula.	East Aurora.	4837
Farmers' Fertilizer Co., Syracuse, N. Y.	Standard phosphate.	East Aurora.	4836
John Finster, Rome, N. Y.	Home trade bone eagle phosphate.	Rome.	4438
H. Fitchard, Minetto, N. Y.	Minetto fertilizer.	Oswego Cent. Oswego.	4926 4933
Geo. B. Forrester, New York City.	Cabbage manure.	Flatlands.	4195
Geo. B. Forrester, New York City.	Complete manure for the potato.	Jamaica.	4064
Geo. B. Forrester, New York City.	Corn manure.	Flatlands.	4196
Geo. B. Forrester, New York City.	Muriate of potash.	Flatlands.	4198

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosph, ric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	——	6	——	2.16	——	——
Found		7.95	10.39	2.83		4.42
Guaranteed	0.82	8	——	1.08	——	——
Found	1.12	9.46	10.19	1.08	0.21	5.71
Guaranteed	1.23	9	——	2	——	——
Found	1.27	10.28	11.87	2.14	0.31	6.60
Guaranteed	1	8	——	2	——	——
Found	0.75	7.13	9.68	1.51	0.35	1.87
Below guarantee	0.25	0.87		0.49		
Guaranteed	3	5.50	——	1.50*	——	——
Found	2.51	8.25	10.41	1.71	1.09	2.87
Below guarantee	0.49					
Guaranteed	4.73	5	——	7	——	——
Found	5.19	6.97	6.97	9.89	4.75	6.35
Guaranteed	3.70	5.50	——	10	——	——
Found	4.77	7	7	9.62	4.58	6.82
Below guarantee				0.38		
Guaranteed	3.91	6.50	——	8	——	——
Found	4.31	6.35	6.35	10.30	4.02	5.93
Guaranteed	——	——	——	50	——	——
Found				50.20		

* Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Geo. B. Forrester, New York City.	Nitrate of soda.	Flatlands.	4197
Geo. B. Forrester, New York City.	Sulphate of ammonia.	Flatlands.	4199
Geneva Coal Company, Geneva, N. Y.	Early trucker.	Geneva.	5244
Geneva Coal Company, Geneva, N. Y.	Oats and barley special.	Geneva.	5242
Geneva Coal Company, Geneva, N. Y.	Ten and ten.	Geneva.	5245
Geneva Coal Company, Geneva, N. Y.	Standard corn and potato manure.	Geneva.	5243
Globe Fertilizer Co., New York City.	Banner fertilizer.	Worthville. Pierrepont Manor.	4900 4906
Globe Fertilizer Co., New York City.	Dauntless.	Worthville. Pierrepont Manor.	4899 4905
Globe Fertilizer Co., New York City.	Prolific.	Pierrepont Manor.	4907

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

	In 100 Pounds of Fertilizer.					
	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed Found	15 15.54	——	——	——	—— 15.54	——
Guaranteed Found	20 20.34	——	——	——	—— 20.34	——
Guaranteed Found Below guarantee	3.30 3.06 0.24	7 8.29	—— 9.64	8 7.97	—— 0.92	—— 5.97
Guaranteed Found	0.82 0.93	8 8.46	—— 10.05	4 4.22	—— 0.49	—— 5.17
Guaranteed Found	——	10 10.92	—— 11.48	10 11.39	——	—— 7.96
Guaranteed Found	2.47 2.69	7 7.33	—— 8.72	8 8.73	—— 0.77	—— 5.12
Guaranteed Found	0.75 0.91	8 9.18	—— 9.60	10 10.89	—— 0.08	—— 6.98
Guaranteed Found	0.75 1.19	8 10.38	—— 13.14	4 3.86	—— 0.47	—— 7.47
Guaranteed Found	2.06 2.02	7 9.06	—— 11.32	7 7.49	—— 0.83	—— 6.64

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Great Eastern Fertilizer Co., Rutland, Vt.	English wheat grower.	Gardnertown. Voorheesville Pearl Creek.	4249 4493 4700
Great Eastern Fertilizer Co., Rutland, Vt.	Garden special.	Jamaica. Orient. Stanley.	4096 4148 5226
Great Eastern Fertilizer Co., Rutland, Vt.	General dissolved bone.	Penn Yan.	5144
Great Eastern Fertilizer Co., Rutland, Vt.	General fertilizer.	Pearl Creek. Gainesville. Dresden.	4701 4731 5161
Great Eastern Fertilizer Co., Rutland, Vt.	Grain and grass.	Camden.	4913
Great Eastern Fertilizer Co., Rutland, Vt.	Half and half.	Sagaponack.	4174
Great Eastern Fertilizer Co., Rutland, Vt.	Northern corn special.	Orient. Gardnertown. Adams.	4149 4250 4898
Great Eastern Fertilizer Co., Rutland, Vt.	Oats, buckwheat and seeding down.	Wellsville. Adams.	4765 4897

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	0.83	8	——	2	——	——
Found	0.87	8.75	10.66	1.94	0.63	4.01
Guaranteed	3.30	6	——	8	——	——
Found	3.44	6.93	8.30	7.85	0.51	4.79
Guaranteed	——	14	——	——	——	——
Found		15.10	15.55			10.56
Guaranteed	0.82	8	——	4	——	——
Found	1.09	8.54	9.67	3.98	0.04	5.07
Guaranteed	2.47	8	——	2	——	——
Found	2.30	7.90	8.56	1.95	1.03	5.28
Guaranteed	3.29	9	——	1	——	——
Found	2.68	9.74	19.25	1.23	0.78	3.39
Below guarantee	0.61					
Guaranteed	2.88	8	——	2	——	——
Found	2.95	8.51	9.91	2.39	0.85	6.31
Guaranteed	0.82	8	——	4	——	——
Found	1.03	8.63	11.62	3.65	0.21	5.61
Below guarantee				0.35		

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand	Locality where sample was taken.	Station number.
Great Eastern Fertilizer Co., Rutland, Vt.	Schodack special.	Stanley.	5225
Great Eastern Fertilizer Co., Rutland, Vt.	Soluble bone and potash.	Dansville. Gainesville. Remsen.	4621 4732 4866
Great Eastern Fertilizer Co., Rutland, Vt.	Vegetable, vine and tobacco fertilizer.	Gardnertown. Wellsville. Camden.	4251 4764 4912
Great Eastern Fertilizer Co., Rutland, Vt.	Wheat special.	Stanley.	5227
Griffith & Boyd, Baltimore, Md.	Cereal bone plant-food.	Franklin Iron Works.	4546
Griffith & Boyd, Baltimore, Md.	Farmers' improved phosphate.	Dundee.	5166
Griffith & Boyd, Baltimore, Md.	Farmers' potato manure.	Gorham.	5216
Griffith & Boyd, Baltimore, Md.	Garden guano.	Gorham.	5217
Griffith & Boyd, Baltimore, Md.	General crop.	Dundee.	5165

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

	In 100 Pounds of Fertilizer.					
	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	0.80	8	——	8	——	——
Found	1.31	10.16	11.20	7.60	0.43	5.24
Below guarantee				0.40		
Guaranteed	——	11	——	2	——	——
Found		11.72	12.08	1.85		2.55
Guaranteed	2.06	8	——	3.25	——	——
Found	2.06	8.38	10.14	3.46	0.67	5.60
Guaranteed	1.60	8	——	2	——	——
Found	1.92	9.15	10.80	2.28	0.41	0.30
Guaranteed	0.82	8	——	2	——	——
Found	0.88	8.44	10.28	2.31	0.36	5.66
Guaranteed	0.82	7	——	1.50	——	——
Found	0.76	7.26	10.21	2.05	0.24	3.11
Guaranteed	0.82	8	——	9	——	——
Found	0.72	7.95	10.01	10.46	0.27	3.66
Guaranteed	1.65	6.50	——	4.50	——	——
Found	1.52	7.59	10.14	3.96		4.72
Below guarantee				0.54		
Guaranteed	0.82	8	——	4	——	——
Found	0.69	7.24	8.90	4.84	0.17	5.05
Below guarantee		0.76				

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER	Trade name or brand.	Locality where sample was taken.	Station number.
Griffith & Boyd, Baltimore, Md.	Grain grower special.	Dundee.	5167
Griffith & Boyd, Baltimore, Md.	Original superphosphate.	Dundee.	5168
John Haefele, Albany, N. Y.	Ground steamed bone, H brand.	Amsterdam. Albany.	4463 4484
Hammond's Slug-Shot Works, Fishkill Landing, N. Y.	Sward food.	Fishkill Landing.	4243
G. L. Harding, Binghamton, N. Y.	Up-to-date general fertilizer.	Binghamton.	4338
Isaac C. Hendrickson, Jamaica, N. Y.	Long Island fertilizer.	Jamaica.	4063
S. M. Hess & Bro., Philadelphia, Pa.	Keystone bone phosphate.	Mattituck.	4138
S. M. Hess & Bro., Philadelphia, Pa.	Potato and truck manure.	Mattituck.	4137
S. M. Hess & Bro., Philadelphia, Pa.	Special potato manure.	Woodhaven.	4093

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

IN 100 POUNDS OF FERTILIZER.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	——	10	——	2	——	——
Found		10.38	12.22	2.08		4.29
Guaranteed	——	14	——	——	——	——
Found		13.55	16.06			9.02
Below guarantee		0.45				
Guaranteed	2.23	——	25.71	——	——	——
Found	3.23		22.12		1.66	
Below guarantee			3.59			
Guaranteed	2.35	——	3.32	4.57	——	——
Found	2.08	0.80	3.41	4.37	1.74	
Below guarantee	0.27					
Guaranteed	3.15	6.25	——	4.50*	——	——
Found	3.86	8.07	11.94	4.83	0.45	3.96
Guaranteed	2	6	——	4	——	——
Found	1.03	5.48	9.88	6.29	0.25	
Below guarantee	0.97	0.52				
Guaranteed	0.80	9	——	1	——	——
Found	1.02	10.53	12.46	1.11	0.56	0.58
Guaranteed	2.50	8	——	6	——	——
Found	2.60	8.06	10.21	7.27	1.47	1
Guaranteed	3.25	8	——	7	——	——
Found	3.51	9.33	10.52	6.82	1.70	4.01

* Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
C. C. Hicks, Penn Yan, N. Y.	Animal bone.	Penn Yan.	5153
C. C. Hicks, Penn Yan, N. Y.	Prolific.	Penn Yan.	5155
C. C. Hicks, Penn Yan, N. Y.	Soluble bone.	Penn Yan.	5154
Hubbard & Co., Baltimore, Md.	Farmers IXL superphosphate.	Franklinville.	4778
Hubbard & Co., Baltimore, Md.	Oriental phosphate for wheat and grass.	Franklinville.	4777
Hubbard & Co., Baltimore, Md.	Warranted pure raw bone.	Franklinville.	4779
Imperial Fertilizer Co., New York City.	L. I. special for potatoes and truck.	Hollis.	4089
Imperial Fertilizer Co., New York City.	Imperial ten per cent. guano.	Hollis.	4090
Ingersoll Packing Co., Ontario, Can.	Bone.	South Lima.	4584

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	1.85	9	——	4	——	——
Found	2.04	9.56	13.85	4.20	0.83	7.20
Guaranteed	0.82	10	——	8	——	——
Found	0.95	10.70	11.47	8.13	0.65	8.21
Guaranteed	——	14	——	——	——	——
Found		13.69	16.80			9.41
Below guarantee		0.31				
Guaranteed	1.64	9	——	1.75	——	——
Found	1.55	10.75	11.96	1.62	0.64	7.39
Guaranteed	0.82	8	——	1.50	——	——
Found	1.11	9.92	11.25	1.59	0.16	6.88
Guaranteed	3.29	——	23	——	——	——
Found	3.29		26.50		0.50	
Guaranteed	3.71	7	——	7	——	——
Found	3.40	9.28	11.41	7.12	2.13	3.64
Below guarantee	0.31					
Guaranteed	8.78	6	——	3	——	——
Found	7.14	7.21	9.73	3.35	4.18	2.80
Below guarantee	1.64					
Guaranteed	4	——	16	——	——	——
Found	4.77		18.51		0.47	

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Ingersoll Packing Co., Ontario, Can.	Brand B.	South Lima.	4583
Ingersoll Packing Co., Ontario, Can.	Flesh.	South Lima.	4581
Ingersoll Packing Co., Ontario, Can.	Flesh and potash.	South Lima.	4582
International Seed Co., Rochester, N. Y.	A-1-special manure.	Queens. Horseheads.	4084 5172
International Seed Co., Rochester, N. Y.	Electric guano.	Holland.	4813
International Seed Co., Rochester, N. Y.	Grain and grass.	Canaseraga. Remsen.	4742 4864
International Seed Co., Rochester, N. Y.	Potato and truck manure.	Oxford. So. Livonia. Remsen.	4366 4577 4865
Geo. A. Ives, Bainbridge, N. Y.	Corn and oats special.	Bainbridge.	4359
Jamestown Fertilizer Co., Jamestown, N. Y.	Grain and seeding brand.	Jamestown.	5098

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

IN 100 POUNDS OF FERTILIZER.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed Found	10 11.93	——	2 2.33	——	—— 0.13	——
Guaranteed Found	7 7.35	——	5 10.76	——	—— 0.29	——
Guaranteed Found	6 7.24	——	4 8.31	7* 7.17	—— 0.54	——
Guaranteed Found	2.40 2.69	6 6.87	—— 9.51	10 10.31	—— 0.79	—— 3.27
Guaranteed Found	0.82 2.14	8 8.62	—— 9.84	2 2.18	—— 1.46	—— 5.24
Guaranteed Found	1.65 1.51	10 10.11	—— 12.31	2 2.16	—— 0.52	—— 5.86
Guaranteed Found	1.25 1.29	8 10.05	—— 11.55	7* 7.60	—— 0.14	—— 6.11
Guaranteed Found	0.82 0.90	8 8.72	—— 10.19	4 4.08	—— 0.51	—— 6.41
Guaranteed Found Below guarantee	0.82 1	7 6.65 0.35	—— 8.19	2 2.59	—— 0.11	—— 3.39

* Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand	Locality where sample was taken.	Station number.
Jamestown Fertilizer Co., Jamestown, N. Y.	Oats and buckwheat special.	Jamestown.	5099
Jamestown Fertilizer Co., Jamestown, N. Y.	Potato, grain and grass.	Jamestown.	5100
Jarecki Chemical Co., Sandusky, Ohio.	Bone and phosphate mixture.	Bath.	5190
Jarecki Chemical Co., Sandusky, Ohio.	Double fish guano.	Bath.	5189
Jarecki Chemical Co., Sandusky, Ohio.	Fish and potash potato and tobacco food.	Bath.	5191
Jarecki Chemical Co., Sandusky, Ohio.	Fish and potash grain special.	Machias.	4799
Jarecki Chemical Co., Sandusky, Ohio.	Lake Erie fish guano.	Machias. Gowanda.	4800 5087
Jarecki Chemical Co., Sandusky, Ohio.	No. 1 fish guano.	Machias. Gowanda.	4798 5084
Jones Fertilizer Co., Cincinnati, Ohio.	Bone and potash.	North Collins.	5064

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

IN 100 POUNDS OF FERTILIZER.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	——	10	——	2	——	——
Found		11.14	11.52	2.49		8.01
Guaranteed	0.82	8	——	4	——	——
Found	0.64	8.41	10.38	2.83	0.11	5.81
Below guarantee				1.17		
Guaranteed	2.10	——	15	0.50*	——	——
Found	3.11		16.72	0.55	0.73	4.63
Guaranteed	2.47	12	——	1	——	——
Found	2.34	11.83	13.01	1.58	1.76	8.36
Guaranteed	0.86	9	——	4	——	——
Found	0.83	11.91	13.12	1.91	0.42	8.05
Below guarantee				2.09		
Guaranteed	1.20	9	——	4	——	——
Found	0.97	10.11	11.97	2.20	0.45	6.53
Below guarantee	0.23			1.80		
Guaranteed	1.75	10	——	1*	——	——
Found	1.82	10.79	12.15	1.45	0.51	6.17
Guaranteed	0.85	10	——	1	——	——
Found	0.82	11.30	12.06	1.22	0.53	6.95
Guaranteed	1.95	8	——	4*	——	——
Found	2.04	6.77	9.82	3.98	0.17	1.04
Below guarantee		1.23				

* Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Jones Fertilizer Co., Cincinnati, Ohio.	Jewel phosphate.	North Collins.	5067
Jones Fertilizer Co., Cincinnati, Ohio.	Jones' reliable.	North Collins.	5066
Jones Fertilizer Co., Cincinnati, Ohio.	Miami Valley phosphate.	North Collins.	5063
Jones Fertilizer Co., Cincinnati, Ohio.	Special tobacco.	North Collins.	5068
Jones Fertilizer Co., Cincinnati, Ohio.	Tobacco and potato grower.	North Collins.	5065
Lackawanna Fertilizer Co., Moosic, Pa.	Acid phosphate.	Southport.	5177
Lackawanna Fertilizer Co., Moosic, Pa.	Alkaline bone.	Southport.	5179
Lackawanna Fertilizer Co., Moosic, Pa.	Bone superphosphate.	Southport.	5181
Lackawanna Fertilizer Co., Moosic, Pa.	Moosic phosphate.	Southport.	5178
Lackawanna Fertilizer Co., Moosic, Pa.	Special manure.	Southport.	5180

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	1.25	9	——	——	——	——
Found	1.05	8.92	11.87		0.08	1.19
Guaranteed	2.05	7.50	——	1.25	——	——
Found	2.62	8.47	13.52	1.81	0.70	3.54
Guaranteed	2.87	9	——	2.75*	——	——
Found	3.22	8.15	12.44	3.67	0.78	2.06
Below guarantee		0.85				
Guaranteed	2.47	9	——	2.50*	——	——
Found	2.57	10.96	15.80	4.17	0.74	1.64
Guaranteed	4.20	8.25	——	6*	——	——
Found	4	8.62	11.26	7.40	0.87	3.55
Guaranteed	——	14	——	——	——	——
Found		16.40	17.28			11.94
Guaranteed	——	8	——	1.62*	——	——
Found		7.94	9.98	2.23		2.98
Guaranteed	1.65	10	——	2	——	——
Found	1.66	10.06	11.66	1.89	0.82	6.64
Guaranteed	1.25	7	——	1.50*	——	——
Found	1.55	7.33	9.23	2.73	0.78	4.97
Guaranteed	2.50	10	——	6.50*	——	——
Found	2.42	10.48	12.18	6.32	1.47	7.22

* Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
F. R. Lalor, Dunnville, Ont., Can.	Canada hard-wood ashes.	Milton. Rome.	4252 4442
Lazaretto Guano Co., Baltimore, Md.	Ammoniated bone phosphate.	Rome.	4433
Lazaretto Guano Co., Baltimore, Md.	Extra ammoniated bone.	Marathon. Rome. Caledonia.	4324 4432 4666
Lazaretto Guano Co., Baltimore, Md.	Extra hop and potato manure.	Hamilton.	4539
Lazaretto Guano Co., Baltimore, Md.	Fruit and vine.	Marathon. Caledonia. Watertown.	4326 4663 4885
Lazaretto Guano Co., Baltimore, Md.	Gaines' bone and potash.	Sherburne.	4392
Lazaretto Guano Co., Baltimore, Md.	Gaines' corn and oat special.	Sherburne.	4391
Lazaretto Guano Co., Baltimore, Md.	Gaines' grain and grass.	Sherburne.	4390
Lazaretto Guano Co., Baltimore, Md.	Gaines' hop and potato.	Sherburne.	4393

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	——	——	1	4.50*	——	——
Found			1.97	5.52		
Guaranteed	0.82	9	——	2	——	——
Found	0.86	8.96	10.69	2.31	0.46	6
Guaranteed	0.82	8	——	4	——	——
Found	0.78	8.20	9.65	4.46	0.34	4.72
Guaranteed	0.82	10	——	8	——	——
Found	0.91	10.65	11.65	7.81	0.39	8.10
Guaranteed	0.82	10	——	8	——	——
Found	0.89	10.77	11.72	7.69	0.34	8.50
Below guarantee				0.31		
Guaranteed	——	10	——	2	——	——
Found		12.58	13.67	2.14		9.27
Guaranteed	1.03	8	——	3	——	——
Found	0.91	8.12	9.53	3.85	0.23	4.79
Guaranteed	0.82	8	——	4	——	——
Found	0.85	8.60	9.97	4.47	0.43	6.09
Guaranteed	0.82	10	——	8	——	——
Found	0.67	10.74	11.63	7	0.11	8.17
Below guarantee				1		

* Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Lazaretto Guano Co., Baltimore, Md.	Landers' corn, oats and buckwheat.	Whitney Pt.	4327
Lazaretto Guano Co., Baltimore, Md.	Landers' special potato manure.	Whitney Pt.	4328
Lazaretto Guano Co., Baltimore, Md.	Leathersich's bone and potash.	Caledonia.	4664
Lazaretto Guano Co., Baltimore, Md.	N. Y. standard No. 2.	Caledonia.	4665
Lazaretto Guano Co., Baltimore, Md.	N. Y. standard potato manure.	Marathon. Watertown.	4325 4883
Lazaretto Guano Co., Baltimore, Md.	Retriever animal bone.	Binghamton.	4354
Lazaretto Guano Co., Baltimore, Md	Special onion and cabbage.	Watertown.	4886
Liebig Manufacturing Co., Carteret, N. J.	Fruit and vine.	Marlborough.	4960
Liebig Manufacturing Co., Carteret, N. J.	Peach tree No. 1.	Marlborough.	4959

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

IN 100 POUNDS OF FERTILIZER.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	1.23	8	——	3	——	——
Found	1.08	9.29	10.57	3.05	0.25	5.52
Guaranteed	0.82	8	——	4	——	——
Found	0.80	8.05	9.77	4.40	0.38	4.91
Guaranteed	——	10	——	5	——	——
Found		10.26	10.98	5.12		7.61
Guaranteed	——	10	——	3	——	——
Found	1.40	9.60	11.67	3.12	0.54	6.50
Below guarantee		0.40				
Guaranteed	2.47	7	——	8	——	——
Found	2.53	7.80	9.39	8	1.28	5.62
Guaranteed	1.85	9	——	4	——	——
Found	1.95	9.20	13.52	4.20	0.60	6.30
Guaranteed	3.29	7	——	8	——	——
Found	3.29	7.20	10.04	8	1.07	4.74
Guaranteed	1.60	8	——	7*	——	——
Found	1.82	9.56	10.44	6.92	0.50	1.60
Guaranteed	1.60	6	——	10*	——	——
Found	1.72	8.66	9.42	10.74	0.38	1.13

* Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Liebig Manufacturing Co., Carteret, N. J.	Potato and corn.	Marlborough.	4956
Liebig Manufacturing Co., Carteret, N. J.	Soluble bone and potash, No. 2.	Marlborough.	4957
Liebig Manufacturing Co., Carteret, N. J.	Standard ammoniated superphosphate.	Marlborough.	4958
Lister's Agri'l Chemical Works, Newark, N. J.	Ammoniated dissolved bone.	Syracuse. Utica.	4276 4452
Lister's Agri'l Chemical Works, Newark, N. J.	Animal bone and potash, No. 1.	Utica. Gainesville. Boonville.	4450 4739 4857
Lister's Agri'l Chemical Works, Newark, N. J.	Animal bone and potash, No. 2.	Gainesville.	4740
Lister's Agri'l Chemical Works, Newark, N. J.	Cauliflower and cabbage fertilizer.	Jamaica.	4073
Lister's Agri'l Chemical Works, Newark, N. J.	Celebrated ground bone.	New Suffolk.	4162
Lister's Agri'l Chemical Works, Newark, N. J.	Corn fertilizer No. 2.	Orient. Otego. Chatham.	4150 4530 4225

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	2.75	6	———	6	———	———
Found	3.03	6.96	9.19	6.04	1.05	3.36
Guaranteed	———	12	———	2	———	———
Found		12.40	14.69	2.23		5.67
Guaranteed	2.25	10	———	1.50	———	———
Found	2.27	10.08	11.25	1.83	0.45	1.55
Guaranteed	1.81	9	———	1.50	———	———
Found	1.95	10.58	12.12	2.39	0.77	7.23
Guaranteed	———	9	———	5	———	———
Found		9.68	10.10	5.20		4.82
Guaranteed	———	10	———	3	———	———
Found		9.63	10.36	2.98		4.75
Below guarantee		0.37.				
Guaranteed	3.70	7.50	———	7	———	———
Found	3.60	8.99	9.72	7.27	2.11	6.97
Guaranteed	2.70	———	12	———	———	———
Found	2.79		12.78		0.86	
Guaranteed	1.81	9.25	———	4	———	———
Found	1.97	10.45	11.22	4.35	0.81	8.71

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Lister's Agri'l Chemical Works, Newark, N. J.	Corn and potato fertilizer.	Wayland.	4611
Lister's Agri'l Chemical Works, Newark, N. J.	Crescent bone dust.	Southampton. Wayland.	4194 4617
Lister's Agri'l Chemical Works, Newark, N. J.	Fruit and vine fertilizer.	Thiells.	4964
Lister's Agri'l Chemical Works, Newark, N. J.	G. brand.	Cortland. Leroy. Walton.	4312 4678 5002
Lister's Agri'l Chemical Works, Newark, N. J.	Harvest Queen phosphate.	Amsterdam. Williamst'wn	4465 4911
Lister's Agri'l Chemical Works, Newark, N. J.	Lawn fertilizer.	Elmira.	5175
Lister's Agri'l Chemical Works, Newark, N. J.	Oneida special.	Earlville. Cazenovia. Nichols.	4384 4413 5029
Lister's Agri'l Chemical Works, Newark, N. J.	Perfect fertilizer.	Geneseo. Holland.	4648 4815
Lister's Agri'l Chemical Works, Newark, N. J.	Potato manure.	Jamaica. Bridgehampton. Fulton.	4072 4167 4937

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	1.65	8	——	3	——	——
Found	1.69	8.48	11.15	3.19	0.53	4.86
Guaranteed	2.26	——	11	——	——	——
Found	2.53		12.34		0.64	
Guaranteed	1.65	——	8	7	——	——
Found	3.49	6.61	10.14	7.89	0.98	
Guaranteed	0.82	8	——	4	——	——
Found	1	8.31	9.90	4.14	0.16	5.58
Guaranteed	1.24	9.50	——	2	——	——
Found	1.45	10.61	13.21	2.10	0.85	7.41
Guaranteed	1.65	8	——	3.50	——	——
Found	1.46	8.97	9.21	3.99	0.96	0.10
Guaranteed	0.62	10	——	1*	——	——
Found	0.80	11.12	12.19	1.17	0.13	8.45
Guaranteed	1.24	9.50	——	2	——	——
Found	1.39	11.18	12.26	1.95	0.55	8.30
Guaranteed	3.70	7.50	——	7	——	——
Found	3.64	8.41	9.51	7.55	1.95	6.64

* Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Lister's Agri'l Chemical Works, Newark, N. J.	Potato manure No. 2.	Thiells. Collins.	4963 5078
Lister's Agri'l Chemical Works, Newark, N. J.	Pure raw bone meal.	Utica. Collins. Nichols.	4449 5081 5031
Lister's Agri'l Chemical Works, Newark, N. J.	Special beet fertilizer.	Utica.	4447
Lister's Agri'l Chemical Works, Newark, N. J.	Special corn fertilizer.	Cortland. Otego. Walton.	4313 4531 5004
Lister's Agri'l Chemical Works, Newark, N. J.	Special crop grower.	Wayland.	4616
Lister's Agri'l Chemical Works, Newark, N. J.	Special potato fertilizer.	Utica. East Aurora. Collins.	4448 4827 5079
Lister's Agri'l Chemical Works, Newark, N. J.	Special ten per cent potato.	Southold. Utica.	4156 4451
Lister's Agri'l Chemical Works, Newark, N. J.	Special tobacco fertilizer.	Fulton.	4936

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	1.81	9.25	——	4	——	——
Found	1.86	10.69	12.31	4.28	0.79	7.83
Guaranteed	2.67	——	23	——	——	——
Found	2.74		24.31		0.64	
Guaranteed	1.65	8	——	3	——	——
Found	1.75	8.52	11.12	3.27	0.68	5.17
Guaranteed	1.65	8	——	3	——	——
Found	1.75	8.84	11.30	3.02	0.60	5.54
Guaranteed	0.83	8	——	1*	——	——
Found	0.83	7.28	9.56	1.40	0.07	2.41
Below guarantee		0.72				
Guaranteed	1.65	8	——	3	——	——
Found	1.67	8.59	11.15	3.28	0.69	4.88
Guaranteed	1.85	8.50	——	10*	——	——
Found	1.73	10.21	11.60	10.09	0.58	7.98
Guaranteed	1.65	8.50	——	4	——	——
Found	2.07	9.42	11.58	3.77	0.88	6.37
Below guarantee				0.23		

* Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Lister's Agri'l Chemical Works, Newark, N. J.	Special wheat fertilizer.	Livonia Station. Mt. Morris. Rushville.	4564 4625 5212
Lister's Agri'l Chemical Works, Newark, N. J.	Standard pure bone superphosphate of lime.	Bridgehampton. Schenectady. Mt. Morris.	4168 4475 4624
Lister's Agri'l Chemical Works, Newark, N. J.	Success fertilizer.	New Suffolk. Syracuse. Wayland.	4161 4275 4612
Lister's Agri'l Chemical Works, Newark, N. J.	U. S. superphosphate.	Wayland. Nichols.	4613 5030
Lister's Agri'l Chemical Works, Newark, N. J.	Vegetable compound.	Walton.	5003
Lonergan & Livingston, Albany, N. Y.	L. & L.	Albany.	4479
Lowell Fertilizer Co., Lowell, Mass.	Acid phosphate.	Cortland.	4308
Lowell Fertilizer Co., Lowell, Mass.	Animal brand.	E. Williston. Carthage.	4110 4875
Lowell Fertilizer Co., Lowell, Mass.	Bone fertilizer for corn and grain.	Greenport. Cortland. Fonda.	4145 4309 4457

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

IN 100 POUNDS OF FERTILIZER.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	1.65	8	——	3	——	——
Found	1.78	9.37	11.34	3.38	0.59	6.58
Guaranteed	2.35	10	——	1.50	——	——
Found	2.18	10.50	12.94	2.07	0.68	7.14
Guaranteed	1.24	9.50	——	2*	——	——
Found	1.35	10.98	12.86	2.08	0.59	8.15
Guaranteed	1.32	7	——	2	——	——
Found	1.55	7.42	9.86	2.63	0.48	3.80
Guaranteed	3.70	7.75	——	7	——	——
Found	3.89	8.62	9.83	7.40	1.83	6.39
Guaranteed	4	8	——	——	——	——
Found	4.65	8.12	16.24		1.77	
Guaranteed	——	13	——	——	——	——
Found		12.83	16.21			9.56
Guaranteed	2.46	9	——	4	——	——
Found	3.15	10.22	11.59	4.09	2.04	7.29
Guaranteed	1.65	8	——	3	——	——
Found	1.70	7.94	9.33	3.13	0.75	3.38

* Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Lowell Fertilizer Co., Lowell, Mass.	Cereal brand.	Cortland.	4306
Lowell Fertilizer Co., Lowell, Mass.	Complete manure for vegetables.	Fonda.	4458
Lowell Fertilizer Co., Lowell, Mass.	Dissolved bone and potash.	Oneonta.	4507
Lowell Fertilizer Co., Lowell, Mass.	Empire brand.	Cortland. Oneonta. Waverly.	4307 4506 5033
Lowell Fertilizer Co., Lowell, Mass.	Fruit and vine for strawberries.	Greenport.	4144
Lowell Fertilizer Co., Lowell, Mass.	Potato phosphate.	E. Williston. Cortland.	4109 4305
Lowell Fertilizer Co., Lowell, Mass.	Tobacco manure.	Corning.	5183
Fred'k Ludlam, New York City.	A. B. F.	Wyoming. New City.	4690 4966
Fred'k Ludlam, New York City.	Cereal brand.	Marathon. Wyoming. New City.	4318 4691 4967

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	0.82	7	——	1	——	——
Found	1.19	7.88	10.48	1.08	0.53	2.51
Guaranteed	2	8	——	3.50*	——	——
Found	2.14	11.24	13.98	3.27	0.98	6.43
Below guarantee				0.23		
Guaranteed	1.65	9		2	——	——
Found	1.98	8.78	11.49	2.29	0.64	6.43
Below guarantee		0.22				
Guaranteed	1.23	7	——	2	——	——
Found	1.26	7.04	8.45	2.31	0.48	1.45
Guaranteed	3.29	8	——	6*	——	——
Found	3.66	8.31	9.81	5.98	1.94	6.45
Guaranteed	2.47	8	——	6*	——	——
Found	2.88	8.74	10.98	6.28	1.35	6.45
Guaranteed	4.92	6	——	8*	——	——
Found	4.76	7.31	7.61	7.43	3.51	4.27
Below guarantee				0.57		
Guaranteed	1.50	8	——	2	——	——
Found	1.70	9.35	11.44	1.95	0.53	5.97
Guaranteed	0.75	8	——	1	——	——
Found	0.84	9.72	12.45	1.12	0.24	6.30

* Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Fred'k Ludlam, New York City.	Dragon's tooth brand.	Bayside. E. Williston.	4105 4112
Fred'k Ludlam, New York City.	Fresh ground bone.	Riverhead.	4133
Fred'k Ludlam, New York City.	Nitrate of soda.	Riverhead.	4134
Fred'k Ludlam, New York City.	Special fertilizer.	Riverhead.	4126
Z. F. Magill, Troy, N. Y.	Crematory ashes.	Fonda.	4456
Mapes Formula and Peruvian Guano Co., New York City.	"A" brand manure.	Little Neck. Binghamton. Collins.	4101 4349 5072
Mapes Formula and Peruvian Guano Co., New York City.	Bone.	Bedford Sta.	4220
Mapes Formula and Peruvian Guano Co., New York City.	Cabbage and cauliflower manure.	Little Neck.	4099
Mapes Formula and Peruvian Guano Co., New York City.	Cereal brand.	Bedford Sta.	4219 4351

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	3	7	——	7	——	——
Found	3.11	8.58	9.73	7.66	1.61	6.40
Guaranteed	2.25	5	18	——	——	——
Found	3.05	12.61	24.80		1.14	
Guaranteed	14.76	——	——	——	——	——
Found	14.80				14.80	
Guaranteed	4	8		10	——	——
Found	4.34	9.34	10.09	10.26	2.30	5.23
Guaranteed	0.56	——	3.91	2.15	——	——
Found	0.12	0.14	0.35	0.22	0	
Below guarantee	0.44		3.56	1.93		
Guaranteed	2.47	10	——	2.50	——	——
Found	2.84	11.32	13.19	3.23	1.93	4.47
Guaranteed	3.29	——	24	——	——	——
Found	3.60		21.24		0.20	
Below guarantee			2.76			
Guaranteed	4.12	6	——	6	——	——
Found	4.32	6.59	8.59	6.73	2.98	2.39
Guaranteed	1.65	6	——	3	——	——
Found	2.03	7.39	9.64	3.57	0.08	4.60

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Mapes Formula and Peruvian Guano Co., New York City.	Complete manure for general use.	Cazenovia.	4415
Mapes Formula and Peruvian Guano Co., New York City.	Complete manure for light soils.	Newburg.	4244
Mapes Formula and Peruvian Guano Co., New York City.	Corn manure.	Little Neck.	4100
Mapes Formula and Peruvian Guano Co., New York City.	Economical potato manure.	Bedford Sta. Binghamton.	4217 4347
Mapes Formula and Peruvian Guano Co., New York City.	Fruit and vine.	Poughkeepsie Clinton.	4234 4544
Mapes Formula and Peruvian Guano Co., New York City.	Grain brand.	Binghamton. Clinton.	4346 4545
Mapes Formula and Peruvian Guano Co., New York City.	Grass and grain spring top-dressing.	Schenectady.	4474
Mapes Formula and Peruvian Guano Co., New York City.	Lawn top dressing	Bedford Sta.	4216
Mapes Formula and Peruvian Guano Co., New York City.	L. I. special potato manure.	Little Neck.	4098

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	3.29	8	——	4	——	——
Found	3.23	7.15	11.52	6.14	1.44	2.48
Below guarantee		0.85				
Guaranteed	4.94	6	——	6	——	——
Found	5.19	5.96	8.96	5.96	1.44	2.09
Guaranteed	2.47	8	——	6	——	——
Found	2.65	9.76	11.16	6.81	1.24	4.19
Guaranteed	3.29	4	——	8*	——	——
Found	3.54	4.54	6.45	7.71	1.80	2.07
Below guarantee				0.29		
Guaranteed	1.65	5	——	10*	——	——
Found	2.26	5.63	7.69	12.77	1.06	3.66
Guaranteed	0.82	8	——	4	——	——
Found	1.10	8.30	9.56	4.83	0.11	5.83
Guaranteed	4.84	5	——	7	——	——
Found	4.82	4.83	7.25	8.04	2.41	1.35
Guaranteed	2.47	——	3.50	2.50	——	——
Found	2.02	3.99	4.43	4.44	1.84	0.94
Below guarantee	0.45					
Guaranteed	3.29	4	——	7*	——	——
Found	3.58	6	8.62	8.24	1.50	2.76

* Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Mapes Formula and Peruvian Guano Co., New York City.	Potato manure.	Bedford Sta. Jamestown.	4218 5090
Mapes Formula and Peruvian Guano Co., New York City.	Root and fruit brand.	Binghamton	4350
Mapes Formula and Peruvian Guano Co., New York City.	Special mixture.	Dundee.	5163
Mapes Formula and Peruvian Guano Co., New York City.	Vegetable manure.	Binghamton. Jamestown.	4348 5091
Maryland Fertilizing Co., Baltimore, Md.	Alkaline bone.	Mt. Morris.	4623
Maryland Fertilizing Co., Baltimore, Md.	Linden superphosphate.	Mt. Morris.	4622
Maxson & Starin, Homer, N. Y.	Complete manure for fruit and vines.	Homer.	4302
Maxson & Starin, Homer, N. Y.	Excelsior brand.	Homer.	4304

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	3.71	8	——	6*	——	——
Found	3.90	6.89	9.49	7.94	1.50	2.92
Below guarantee		1.11				
Guaranteed	0.82	8	——	9	——	——
Found	1	7.86	9.12	9.18	0.05	5.74
Guaranteed	3.50	6.50	——	12.50*	——	——
Found	3.84	9.09	9.97	12.51	1.97	5.88
Guaranteed	4.94	6	——	6	——	——
Found	4.76	7.76	9.41	5.81	1.44	5.25
Guaranteed	——	11.75	——	3.50	——	——
Found		10.63		2.52		4.88
Below guarantee		1.12		0.98		
Guaranteed	——	11	——	2.50	——	——
Found		11.31	13.07	2.18		7.01
Below guarantee				0.32		
Guaranteed	1.65	7	——	9	——	——
Found	2.85	9	10.10	7.66	1.78	4.98
Below guarantee				1.24		
Guaranteed	0.82	7	——	3	——	——
Found	0.83	7.36	10.21	3.11	0.36	4.96

* Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Maxson & Starin, Homer, N. Y.	Fruit and vine No. 2.	Homer.	4303
Maxson & Starin, Homer, N. Y.	Potato and cabbage special.	Cortland.	4316
Maxson & Starin, Homer, N. Y.	Standard potato and corn grower.	Cortland.	4315
Maxson & Starin, Homer, N. Y.	Three X guano.	Homer.	4301
Maxson & Starin, Homer, N. Y.	Vegetable and onion special.	Cortland.	4314
Michigan Carbon Works, Detroit, Mich.	Acid phosphate.	East Aurora. Ellicottville.	4828 5106
Michigan Carbon Works, Detroit, Mich.	Banner dissolved bone.	Livonia Sta. East Aurora.	4563 4834
Michigan Carbon Works, Detroit, Mich.	Desiccated bone.	Holland. East Aurora.	4819 4833
Michigan Carbon Works, Detroit, Mich.	Half desiccated bone and half dissolved bone mixed.	Holland.	4820

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

	In 100 Pounds of Fertilizer.					
	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	0.82	10	——	8	——	——
Found	0.88	9.78	10.79	8.28	0.26	5.54
Below guarantee		0.22				
Guaranteed	3.70	8	——	6	——	——
Found	3.17	7.73	9.64	7.08	0.94	5.69
Below guarantee	0.53	0.27				
Guaranteed	2.47	7	——	8	——	——
Found	2.40	7.58	8.91	7.83	1.23	5.57
Guaranteed	0.82	8	——	4	——	——
Found	0.87	8.66	9.76	4.20	0.62	5.01
Guaranteed	4.95	8	——	6	——	——
Found	4.24	7.33	8.03	8.15	1.75	5.16
Below guarantee	0.71	0.67				
Guaranteed	——	13	——	——	——	——
Found		13.23	14.74			3.87
Guaranteed	——	30	——	——	——	——
Found		33.27	36.48			
Guaranteed	1.25	——	25	——	——	——
Found	1.45		31.29		0.37	
Guaranteed	0.60	7	20	——	——	——
Found	0.97	8.44	23.15		0.36	

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand	Locality where sample was taken.	Station number.
Michigan Carbon Works, Detroit, Mich.	Homestead A boneblack.	Seneca.	4940
Michigan Carbon Works, Detroit, Mich.	Homestead potato grower.	East Aurora. Brocton. Cassadaga.	4832 5137 5239
Michigan Carbon Works, Detroit, Mich.	Jarves drill phosphate.	Holland. North Collins.	4818 5048
Michigan Carbon Works, Detroit, Mich.	Red line ammoniated phosphate.	East Aurora. Ellicottville.	4831 5105
Michigan Carbon Works, Detroit, Mich.	Red line complete manure.	East Aurora. North Collins.	4829 5045
Michigan Carbon Works, Detroit, Mich.	Red line phosphate with potash.	East Aurora. Brocton.	4830 5136
Milsom Rendering and Fertilizing Co., Buffalo, N. Y.	Acidulated bone and potash.	York. Castile. Penn Yan.	4630 4729 5147
Milsom Rendering and Fertilizing Co., Buffalo, N. Y.	Ammoniated bone and potash.	Halls.	5229
Milsom Rendering and Fertilizing Co., Buffalo, N. Y.	Buckwheat special	Whitney Pt. Machias. Campville.	4337 4803 5022

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosph-ric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	2.25	9	——	1.75	——	——
Found	2.06	11.02	11.54	2.12*	0.75	8.40
Guaranteed	1.94	8.50	——	5	——	——
Found	1.82	12.14	12.42	5.64	0.98	11.11
Guaranteed	1.03	8	——	0.75	——	——
Found	1.50	8.67	9.31	1.32	0.56	5.90
Guaranteed	1.65	8	——	——	——	——
Found	2	9.56	10.93		0.13	5.48
Guaranteed	1.05	8	——	1.50	——	——
Found	1.15	8.74	10.20	1.51	0.19	5.38
Guaranteed	——	10	——	3	——	——
Found		11.80	12.60	2.96		2.34
Guaranteed	——	10	——	6	——	——
Found		11.01	11.34	5.53		6.91
Below guarantee				0.47		
Guaranteed	2.46	8	——	7	——	——
Found	2.22	7.88	9.21	7.13	0.67	5.98
Below guarantee	0.24					
Guaranteed	0.80	7	——	1	——	——
Found	0.86	7.69	9.46	1.08	0.42	4.31

* Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Milsom Rendering and Fertilizing Co., Buffalo, N. Y.	Buffalo fertilizer.	Tully. Perry. Campville.	4297 4716 5020
Milsom Rendering and Fertilizing Co., Buffalo, N. Y.	Buffalo guano.	Sidney. Castile. Campville.	4361 4728 5021
Milsom Rendering and Fertilizing Co., Buffalo, N. Y.	Cabbage special.	Gorham. Halls.	5219 5228
Milsom Rendering and Fertilizing Co., Buffalo, N. Y.	Celery special.	East Avon.	4658
Milsom Rendering and Fertilizing Co., Buffalo, N. Y.	Celery special No. 6.	South Lima.	4588
Milsom Rendering and Fertilizing Co., Buffalo, N. Y.	Corn fertilizer.	Cincinnatus. Franklinville.	4335 4785
Milsom Rendering and Fertilizing Co., Buffalo, N. Y.	Cyclone bone meal.	Perry. Franklinville. Milton.	4717 4789 4949
Milsom Rendering and Fertilizing Co., Buffalo, N. Y.	Dissolved bone.	Livonia Sta. Boonville. Milton.	4568 4862 4950

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	1.85	8	——	1.50	——	——
Found	1.82	7.84	10.48	1.53	0.92	5.03
Guaranteed	0.82	8	——	4	——	——
Found	0.80	9.06	10.57	4.09	0.47	6.88
Guaranteed	1.65	7	——	9	——	——
Found	1.66	6.85	9.22	9.06	0.86	5.23
Guaranteed	4.12	8	——	12	——	——
Found	4.34	10.12	10.34	12.07	0.09	8.21
Guaranteed	3	8	——	12*	——	——
Found	3.20	10.18	10.32	11.21	0.73	9.27
Below guarantee				0.79		
Guaranteed	2.50	8	——	2	——	——
Found	2.10	8.27	9.73	2.24	0.28	5.83
Below guarantee	0.40					
Guaranteed	2.47	——	22	——	——	——
Found	3.21		23.51		1.55	
Guaranteed	——	11	——	——	——	——
Found		13.05	13.29			5.37

* Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Milsom Rendering and Fertilizing Co., Buffalo, N. Y.	Dissolved bone-black.	Livonia Sta.	4571
Milsom Rendering and Fertilizing Co., Buffalo, N. Y.	Dissolved bone and potash.	McDonough. Machias. Milton.	4368 4805 4951
Milsom Rendering and Fertilizing Co., Buffalo, N. Y.	Erie king.	Syracuse. Tyner. Castile.	4274 4367 4730
Milsom Rendering and Fertilizing Co., Buffalo, N. Y.	Fourteen per cent acid phosphate.	Penn Yan.	4947
Milsom Rendering and Fertilizing Co., Buffalo, N. Y.	Grain special No. 1.	Livonia Sta.	4570
Milsom Rendering and Fertilizing Co., Buffalo, N. Y.	Lima special for celery.	South Lima.	4587
Milsom Rendering and Fertilizing Co., Buffalo, N. Y.	Milsom No. 2.	Sidney.	4360
Milsom Rendering and Fertilizing Co., Buffalo, N. Y.	Potato, hop and tobacco phosphate.	Syracuse. Calverton. Franklinville.	4273 4132 4788

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

	In 100 Pounds of Fertilizer.					
	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	—	16	—	—	—	—
Found		15.80	16.08			13.68
Guaranteed	—	9	—	1.65	—	—
Found		10.70	11.26	1.50		5.91
Guaranteed	0.80	7	—	2	—	—
Found	0.78	7.49	7.70	2.11	0.45	4.72
Guaranteed	—	14	—	—	—	—
Found		13.99	15.89			10.51
Guaranteed	1	10	—	6	—	—
Found	0.88	9.71	11.43	6.94	0.40	6.48
Below guarantee		0.29				
Guaranteed	1	7	—	15	—	—
Found	0.83	6.91	8.81	12.21	0.54	4.51
Below guarantee				2.79		
Guaranteed	0.82	8	—	2	—	—
Found	0.83	8.05	9.42	1.71	0.44	5.72
Below guarantee				0.29		
Guaranteed	2.06	8	—	4	—	—
Found	1.97	8.85	9.36	4.02	0.47	6.31

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Milsom Rendering and Fertilizing Co., Buffalo, N. Y.	Special bean fertilizer.	Livonia Sta. York. Perry.	4572 4631 4713
Milsom Rendering and Fertilizing Co., Buffalo, N. Y.	Special cabbage and tobacco manure.	Halls.	5230
Milsom Rendering and Fertilizing Co., Buffalo, N. Y.	Special potato.	Calverton. Perry. Gorham.	4131 4714 5218
Milsom Rendering and Fertilizing Co., Buffalo, N. Y.	Vegetable bone fertilizer.	Livonia Sta. Fenton. Southport.	4569 5062 5176
Milsom Rendering and Fertilizing Co., Buffalo, N. Y.	Wheat, oats and barley phosphate	Syracuse. South Lima. Campville.	4122 4601 5023
Mittenmaier & Son, Rome, N. Y.	Hop and potato.	Rome.	4437
Mittenmaier & Son, Rome, N. Y.	Pride of America.	Rome.	4435
Mittenmaier & Son, Rome, N. Y.	Superphosphate.	Rome.	4436

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

IN 100 POUNDS OF FERTILIZER.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	0.82	10	——	4	——	——
Found	0.80	10.27	11.49	4.28	0.52	7.27
Guaranteed	4	7	——	9	——	——
Found	3.86	8.81	10.43	9.22	0.11	6.85
Guaranteed	1.64	8	——	8	——	——
Found	1.59	9.45	10.31	8.54	0.40	5.29
Guaranteed	4.12	8	——	5	——	——
Found	3.90	8.42	10.49	5.18	1.40	5.46
Below guarantee	0.22					
Guaranteed	1.23	8	——	2	——	——
Found	1.15	8.48	9.61	1.97	0.63	6.48
Guaranteed	1	6.50	——	3*	——	——
Found	1.35	6.56	12.31	3.32	0.48	2.44
Guaranteed	1	6	——	2	——	——
Found	1.56	5.69	11.11	2.18	0.65	2.07
Below guarantee		0.31				
Guaranteed	2	8	——	3*	——	——
Found	1.91	8.34	14.68	4.18	0.80	4.04

* Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Moller & Co., Maspeth, N. Y.	Champion No. 1.	Woodhaven.	4091
Moller & Co., Maspeth, N. Y.	Champion No. 2.	Woodhaven.	4092
Frank Muckle, Albany, N. Y.	[Not given.]	Albany.	4478
George L. Munroe, Oswego, N. Y.	Canada hardwood ashes.	Moscow.	4632
National Fertilizer Co., Bridgeport, Conn.	Chittenden's universal phosphate.	Utica.	4446
National Fertilizer Co., Bridgeport, Conn.	Complete fertilizer for potatoes and onions.	Queens.	4088
National Fertilizer Co., Bridgeport, Conn.	Fish and potash.	Mattituck.	4166
National Fertilizer Co., Bridgeport, Conn.	Market garden fertilizer.	Mattituck.	4165
Newburg Rendering Co., Newburg, N. Y.	Pure meat and bone.	Newburg.	4248

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

	In 100 Pounds of Fertilizer.					
	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	3.30	6	—	6*	—	—
Found	2.96	7.47	11.53	6.76	2.06	3.54
Below guarantee	0.34					
Guaranteed	4.12	6	—	5*	—	—
Found	3.05	7.81	11.73	6.77	2.17	3.50
Below guarantee	1.07					
Guaranteed	—	—	—	—	—	—
Found	3.68	3.70	7.78		0.81	00
Guaranteed	—	—	1	4	—	—
Found			1.17	5.83		
Guaranteed	0.82	9	—	1	—	—
Found	0.90	12.93	14.03	0.92	0.45	0.15
Guaranteed	3.30	8	—	6	—	—
Found	3.68	8.93	10.60	6.34	1.60	4.45
Guaranteed	3	—	6	4*	—	—
Found	2.93	5.50	9.73	4.55	0.40	2.51
Guaranteed	2.50	7	—	6	—	—
Found	2.73	7.73	9.40	6.11	1.02	3.89
Guaranteed	4	—	20	—	—	—
Found	4.94		18.84		1.22	
Below guarantee			1.16			

* Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Niagara Fertilizer Works, Buffalo. N. Y.	Grain and grass grower.	Cobleskill. North Boston Nichols.	4499 4843 5028
Niagara Fertilizer Works, Buffalo. N. Y.	Irvin & Tugwell's bone black fertilizer.	Sinclairville.	5238
Niagara Fertilizer Works, Buffalo. N. Y.	Potato, tobacco and hop fertilizer.	Cobleskill. Lowville. Nichols.	4497 4874 5027
Niagara Fertilizer Works, Buffalo. N. Y.	Queen City phosphate.	Almond. No. Boston.	4752 4842
Niagara Fertilizer Works, Buffalo. N. Y.	Wheat and corn producer.	Sherburne. Pearl Creek. Dunkirk.	4404 4694 5122
Niagara Fertilizer Works, Buffalo. N. Y.	Wheat and grass.	Pearl Creek.	4695
Northwestern Fertilizer Co., Chicago, Ill.	Dissolved bone phosphate.	North Collins.	5050
Northwestern Fertilizer Co., Chicago, Ill.	Garden City superphosphate.	Westfield.	5141
Northwestern Fertilizer Co., Chicago, Ill.	Potato grower.	Westfield.	5237

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

IN 100 POUNDS OF FERTILIZER.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	0.82	7	—	1.08	—	—
Found	1.08	7.66	9.39	1.12	0.12	3.72
Guaranteed	1.85	8	—	1.62	—	—
Found	2.14	8.95	9.74	2.31	0.74	6.59
Guaranteed	1.64	8	—	2.70	—	—
Found	1.62	10.02	11.67	2.84	0.33	7.19
Guaranteed	—	11	—	—	—	—
Found		11.76	11.92			8.43
Guaranteed	1.23	8	—	2	—	—
Found	1.30	8.27	9.22	2.16	0.60	5.0[illegible]
Guaranteed	0.82	7	—	1.08	—	—
Found	1	8.04	12.14	1.31	0.48	2.7[illegible]
Guaranteed	1.23	11	—	—	—	—
Found	1.65	12.82	14.91		0.54	7.23
Guaranteed	2.05	8	—	0.54*	—	—
Found	2.57	8.12	9.49	0.92	1.01	5.02
Guaranteed	2.46	8	—	2	—	—
Found	2.70	8.07	10.42	2.60	1.74	3.72

* Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Northwestern Fertilizer Co., Chicago, Ill.	Prairie phosphate.	Westfield.	5142
Northwestern Fertilizer Co., Chicago, Ill.	Pure ground bone.	North Collins.	5051
Oakfield Fertilizer Co., Oakfield, N. Y.	Domestic.	Conesus. Geneseo.	4610 4641
Oakfield Fertilizer Co., Oakfield, N. Y.	Genesee county wheat grower.	Caledonia. Franklinville.	4660 4784
Oakfield Fertilizer Co., Oakfield, N. Y.	Golden sheaf.	Conesus. North Collins. Gorham.	4609 5047 5220
Oakfield Fertilizer Co., Oakfield, N. Y.	Great value.	Caledonia. Conesus.	4659 4608
Oakfield Fertilizer Co., Oakfield, N. Y.	High-farming fertilizer.	Geneseo.	4642
Oakfield Fertilizer Co., Oakfield, N. Y.	Milton's special.	Seneca.	4941
Oakfield Fertilizer Co., Oakfield, N. Y.	Potato and tobacco fertilizer.	Leroy.	4667

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	1.64	6	——	——	——	——
Found	2.70	7.9[illegible]	9.68		1.04	5.10
Guaranteed	2.46	——	18	——	——	——
Found	3.62		22.04		0.36	
Guaranteed	1.64	8	——	1.08	——	——
Found	1.78	9.65	10.55	1.43	0.05	4.92
Guaranteed	1	10	——	5	——	——
Found	0.84	9.94	10.34	4.93	0.04	6.02
Guaranteed	1.23	7	——	1.90	——	——
Found	1.50	8	8.73	2.27	0.03	4.42
Guaranteed	0.82	6	——	1.08	——	——
Found	0.87	6.43	6.76	1.06	0	3.34
Guaranteed	1.85	8	——	2.43	——	——
Found	1.95	8.13	9.13	2.86	0.05	5.16
Guaranteed	4	7	——	9	——	——
Found	3.41	4.87	7.22	8.84	1.19	2.23
Below guarantee	0.59	2.13				
Guaranteed	2.47	6	——	4.32	——	——
Found	2.35	4.06	6.80	4.19	0.16	1.54
Below guarantee		1.94				

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER	Trade name or brand.	Locality where sample was taken.	Station number.
Oneonta Fertilizer and Chemical Co., Oneonta, N. Y.	Buckwheat fertilizer.	Oneonta.	4511
Oneonta Fertilizer and Chemical Co., Oneonta, N. Y.	Complete corn manure.	Oneonta.	4526
Oneonta Fertilizer and Chemical Co., Oneonta, N. Y.	Complete manure AA brand.	Oneonta.	4523
Oneonta Fertilizer and Chemical Co., Oneonta, N. Y.	Complete manure for cabbage and cauliflower.	Oneonta.	4513
Oneonta Fertilizer and Chemical Co., Oneonta, N. Y.	Complete manure for hops.	Oneonta.	4522
Oneonta Fertilizer and Chemical Co., Oneonta, N. Y.	Complete manure for vegetables.	Oneonta.	4521
Oneonta Fertilizer and Chemical Co., Oneonta, N. Y.	Complete potato manure.	Oneonta.	4525
Oneonta Fertilizer and Chemical Co., Oneonta, N. Y.	Corn fertilizer.	Cobleskill. Oneonta.	4496 4519
Oneonta Fertilizer and Chemical Co., Oneonta, N. Y.	Economical manure.	Oneonta.	4512

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	1.65	5	——	1	——	——
Found	2.20	5.87	6.81	2.13	0.94	2.27
Guaranteed	3.70	7	——	6	——	——
Found	3.97	7.56	8.47	6.74	1.82	5.25
Guaranteed	2.50	10	——	2.50	——	——
Found	2.66	10.58	11.82	3.45	1.09	5.42
Guaranteed	4.10	6	——	8	——	——
Found	4.01	5.97	7.67	8.98	0.86	2.02
Guaranteed	5	6	——	6	——	——
Found	4.80	10.32	11.03	6.84	2.22	4.47
Guaranteed	5	6	——	6	——	——
Found	4.88	6.46	7.13	6.96	2.23	4.38
Guaranteed	3.70	7.50	——	7*	——	——
Found	3.62	8.20	8.87	6.22	1.62	5.99
Below guarantee				0.78		
Guaranteed	2.50	6	——	3	——	——
Found	2.68	5.80	6.64	3.01	0.98	2.84
Guaranteed	1.65	5	——	5	——	——
Found	2.10	5.58	6.16	5.30	0.81	1.82

* Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Oneonta Fertilizer and Chemical Co., Oneonta, N. Y.	Fruit and vine fertilizer.	Oneonta.	4527
Oneonta Fertilizer and Chemical Co., Oneonta, N. Y.	Hop phosphate.	Cobleskill. Oneonta.	4494 4516
Oneonta Fertilizer and Chemical Co., Oneonta, N. Y.	Lawn and garden enricher.	Oneonta.	4514
Oneonta Fertilizer and Chemical Co., Oneonta, N. Y.	Potato fertilizer.	Cobleskill. Oneonta.	4495 4518
Oneonta Fertilizer and Chemical Co., Oneonta, N. Y.	Standard superphosphate.	Oneonta.	4524
Oneonta Fertilizer and Chemical Co., Oneonta, N. Y.	Superphosphate — apex brand.	Oneonta.	4517
Oneonta Fertilizer and Chemical Co., Oneonta, N. Y.	Superphosphate — success brand.	Oneonta.	4520
Oneonta Fertilizer and Chemical Co., Oneonta, N. Y.	Superphosphate with potash.	Oneonta.	4515
Pacific Guano Co., Boston, Mass.	Ammoniated dissolved bone.	Oneida. Livonia Sta. Pavilion.	4422 4566 5119

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed Found	1.65 1.55	5.50 6.75	——— 6.92	10* 10.36	——— 0.51	——— 3.59
Guaranteed Found	1.65 1.93	9 10.10	——— 10.85	4* 4.24	——— 0.57	——— 7.06
Guaranteed Found	1.65 2.31	3 3.99	——— 5.20	1.50 2.05	——— 1.01	——— 1.03
Guaranteed Found	1.85 2.09	6 6.32	——— 6.74	5* 5.33	——— 1.06	——— 2.66
Guaranteed Found	1.65 2.09	7 7.54	——— 7.95	3 3.53	——— 1.23	——— 3.78
Guaranteed Found	0.82 1.01	8 8.56	——— 9.14	1.50 1.88	——— 0.39	——— 4.12
Guaranteed Found	1 1.42	8 7.99	——— 9.35	2.50 3.43	——— 0.52	——— 2.94
Guaranteed Found Below guarantee	———	8 10.03	——— 10.32	4 3.74 0.26	———	——— 7.34
Guaranteed Found	1.64 1.78	9 9.65	——— 12.12	2 1.97	——— 0.80	——— 2.16

* Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Pacific Guano Co., Boston, Mass.	A No. 1 phosphate.	Sherburne. Livonia Sta. Pavilion.	4398 4565 5120
Pacific Guano Co., Boston, Mass.	Dissolved bone phosphate.	Oneida. Amsterdam.	4423 4459
Pacific Guano Co., Boston, Mass.	Dissolved bone and potash.	Ellicottville.	5108
Pacific Guano Co., Boston, Mass.	Fine ground bone.	East Aurora.	4826
Pacific Guano Co., Boston, Mass.	Lowe's ammoniated bone.	Leroy.	4670
Pacific Guano Co., Boston, Mass.	Lowe's bone and potash.	Leroy.	4672
Pacific Guano Co., Boston, Mass.	Lowe's bone and potash for grain.	Leroy.	4673
Pacific Guano Co., Boston, Mass.	Nobsque guano.	Amsterdam. Scottsburg. Leroy.	4460 4629 4671
Pacific Guano Co., Boston, Mass.	Potato phosphate.	Sherburne. Amsterdam.	4399 4461

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

	In 100 Pounds of Fertilizer.					
	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed Found	1.03 1.26	7 8.63	—— 10.70	1.50 2.08	—— 0.70	—— 4.12
Guaranteed Found	——	13 16.10	—— 16.99	——	——	—— 12.05
Guaranteed Found	——	10 10.88	—— 13.01	2 2.07	——	—— 6.78
Guaranteed Found	1.64 2.41	——	11 17.63	——	—— 0.62	——
Guaranteed Found	0.82 1.12	8 9.14	—— 11.06	4 3.87	—— 0.39	—— 5.02
Guaranteed Found	——	10 10.94	—— 12.93	2 1.96	——	—— 6.99
Guaranteed Found Below guarantee	——	10 9.36 0.64	—— 13.37	2 2.25	——	—— 2.93
Guaranteed Found	1.15 1.33	8 8.23	—— 11.41	2 2.20	—— 0.73	—— 3.35
Guaranteed Found	1.23 1.53	6 6.59	—— 9.58	5 5.09	—— 0.83	—— 1.86

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Pacific Guano Co., Boston, Mass.	Potato, tobacco and hop fertilizer.	Sherburne. Oneida.	4401 4424
Pacific Guano Co., Boston, Mass.	Soluble Pacific guano.	Sherburne.	4400
Packers' Union Fertilizer Co., New York City.	American wheat and rye grower.	Poughkeepsie	4235
Packers' Union Fertilizer Co., New York City.	Animal corn fertilizer.	Tallmans.	4973
Packers' Union Fertilizer Co., New York City.	Gardener's complete manure.	Poughkeepsie	4239
Packers' Union Fertilizer Co., New York City.	High-grade American wheat and rye grower.	Pearl Creek.	4692
Packers' Union Fertilizer Co., New York City.	High-grade potato manure.	Southold.	4157
Packers' Union Fertilizer Co., New York City.	Universal fertilizer.	Hudson. Ephratah. Pearl Creek.	4232 4455 4693
Packers' Union Fertilizer Co., New York City.	Wheat, oats and clover.	Poughkeepsie	4236

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

	In 100 Pounds of Fertilizer.					
	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	2.06	8	———	3	———	———
Found	2.44	7.83	12.63	3.34	0.78	2.58
Guaranteed	2.05	8	———	1.50	———	———
Found	2.08	8.47	11.82	1.68	0.57	3.03
Guaranteed	0.82	8	———	2	———	———
Found	1.19	8.79	10.04	2.47	0.15	6.07
Guaranteed	2.47	8	———	2	———	———
Found	2.31	7.90	9.26	2.36	0.95	5.03
Guaranteed	2.47	8	———	10*	———	———
Found	2.41	8.35	9.98	9.93	0.15	6.55
Guaranteed	0.82	8	———	2	———	———
Found	1.14	8.22	9.50	4.06	0.31	5.76
Guaranteed	2.06	8	———	6	———	———
Found	2.14	8.85	10.29	6.45	0.32	6.77
Guaranteed	0.82	8	———	5	———	———
Found	1.16	8.21	9.63	4.95	0.18	5.35
Guaranteed	———	11	———	2	———	———
Found		11.22	12.86	1.86		6.87

* Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand	Locality where sample was taken.	Station number.
J. E. Phelps, Jamaica, N. Y.	Cabbage, potato and vegetable fertilizer.	Aquebogue.	4136
J. E. Phelps, Jamaica, N. Y.	Standard potato and vegetable fertilizer.	Aquebogue.	4135
Moro Phillips' Chemical Co., Philadelphia, Pa.	Acid phosphate.	Oneida.	4420
Moro Phillips' Chemical Co., Philadelphia, Pa.	Farmers' phosphate.	Corning.	5186
Moro Phillips' Chemical Co., Philadelphia, Pa.	Nitrate of soda.	Oneida.	4421
B. J. Pine, East Williston, N. Y.	No. 1 star raw bone superphosphate.	E. Williston.	4107
B. J. Pine, East Williston, N. Y.	No. 2 star raw bone superphosphate.	E. Williston.	4108
L. S. Pitkin, Lorraine, N. Y.	Northern corn grower.	Lorraine.	4901
Potomac Fertilizer Co., Baltimore, Md.	Ammoniated bone.	Delhi.	5000

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	4.10	6	——	8	——	——
Found	4.55	7.28	8.59	7.40	1.26	2.66
Below guarantee				0.60		
Guaranteed	3 28	5	——	10	——	——
Found	3.41	7.45	8.33	10.47	1.51	4.18
Guaranteed	——	14	——	——	——	——
Found		13.89	15.43			11.34
Guaranteed	0.80	7	——	1*	——	——
Found	1.03	8.92	9.65	1.07	0.49	4.63
Guaranteed	——	——	——	——	——	——
Found	13.47				13.47	
Guaranteed	2.47	6	——	7	——	——
Found	2.29	7.04	9.19	7.32	0.95	4.33
Guaranteed	2	6	——	3	——	——
Found	2.46	6.54	9.37	4.09	0.88	4.04
Guaranteed	0.82	8	——	4	——	——
Found	1.12	7.80	9.12	4.51	0.32	5.90
Guaranteed	0.82	9	——	2	——	——
Found	1.16	8.90	10.59	2.49	0.44	5.86

* Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER	Trade name or brand.	Locality where sample was taken.	Station number.
Potomac Fertilizer Co., Baltimore, Md.	Barley and oats.	Peoria.	4703
Potomac Fertilizer Co., Baltimore, Md.	Corn and oats.	Sherburne. Delhi.	4387 5001
Potomac Fertilizer Co., Baltimore, Md.	Corn special.	Oxford.	4370
Potomac Fertilizer Co., Baltimore, Md.	Eureka.	Peoria.	5115
Potomac Fertilizer Co., Baltimore, Md.	Extra ammoniated bone.	Peoria.	5117
Potomac Fertilizer Co., Baltimore, Md.	Nitrate of soda.	Sherburne.	4389
Potomac Fertilizer Co., Baltimore, Md.	Potato and bean special.	Peoria.	5116
Potomac Fertilizer Co., Baltimore, Md.	Potato, grain and grass.	Delhi. Sherburne.	4388 4851
Potomac Fertilizer Co., Baltimore, Md.	Wheat and barley special.	Peoria.	4702

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	——	10	——	3*	——	——
Found		9.97	15.53	3.10		3.31
Guaranteed	1.03	8	——	3	——	——
Found	0.99	7.96	9.82	4.18	0.21	5.83
Guaranteed	0.82	8	——	4	——	——
Found	1.06	8.33	9.93	4.02	0.38	5.1[illegible]
Guaranteed	——	12	——	4*	——	——
Found		12.11	17.28	4.08		6.3[illegible]
Guaranteed	0.82	8	——	4*	0.13	——
Found	0.65	8.06	13.58	4.30		1.6[illegible]
Guaranteed	15.50	——	——	——	——	——
Found	15.74				15.74	
Guaranteed	0.82	10	——	8	——	——
Found	1	10.53	15.25	8.09	0.31	6.11
Guaranteed	0.82	8	——	4	——	——
Found	0.96	8.11	9.56	3.73	0.32	5.48
Below guarantee				0.27		
Guaranteed	1.03	10	——	4*	——	——
Found	1.01	11.12	15.85	3.67	0	5.99
Below guarantee				0.33		

* Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Preston Fertilizer Co., Brooklyn, N. Y.	Ammoniated bone superphosphate.	Milton.	4954
Preston Fertilizer Co., Brooklyn, N. Y.	Bone and potash.	Voorheesville	4492
Preston Fertilizer Co., Brooklyn, N. Y.	Cabbage and cauliflower fertilizer.	Jamaica.	4066
Preston Fertilizer Co., Brooklyn, N. Y.	Fruit and vine.	Milton.	4953
Preston Fertilizer Co., Brooklyn, N. Y.	Pioneer.	Pine Island.	4983
Preston Fertilizer Co., Brooklyn, N. Y.	Potato fertilizer.	Jamaica.	4065
Preston Fertilizer Co., Brooklyn, N. Y.	Potato and onion.	Florida.	4978
Preston Fertilizer Co., Brooklyn, N. Y.	Special for potato and general garden use.	Milton.	4955
Pritchard & Cobbs, Fredonia, N. Y.	Buckwheat fertilizer.	Fredonia.	5123

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

IN 100 POUNDS OF FERTILIZER.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	2.50	8	——	2*	——	——
Found	2.43	8.44	14.37	2.08	0.72	4.38
Guaranteed	2.88	——	20	5*	——	——
Found	2.45		25.03	1.48	1.50	
Below guarantee	0.43			3.52		
Guaranteed	3.25	5	——	7	——	——
Found	3.32	9.09	12.66	7.29	2.03	4.72
Guaranteed	1.65	7	——	10	——	——
Found	1.68	8.02	11.45	10.93	0.35	4.87
Guaranteed	1.25	8	——	1.75	——	——
Found	1.69	10.11	14.81	2.76	0.76	5.89
Guaranteed	3.25	8	——	7*	——	——
Found	3.29	8.41	12.55	7.53	2.07	4.79
Guaranteed	2.25	6	——	6	——	——
Found	2.62	7.95	13	6.71	0.98	1.72
Guaranteed	3.25	5	——	10*	——	——
Found	3.05	6.74	9.58	11.50	1.42	2.74
Guaranteed	0.82	7	——	1.08	——	——
Found	1.20	8.06	10.05	1.10	0.20	3.30

* Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand	Locality where sample was taken.	Station number.
The Quinnipiac Co., New York City.	Ammoniated dissolved bone.	Oswego Center.	4929
The Quinnipiac Co., New York City.	Climax phosphate.	Canaseraga. Canisteo. Rushville.	4741 4744 5210
The Quinnipiac Co., New York City.	Corn and grain.	Southampton.	4193
The Quinnipiac Co., New York City.	Cross fish and potash.	East Marion.	4153
The Quinnipiac Co., New York City.	Dissolved bone and potash.	Walton.	5006
The Quinnipiac Co., New York City.	Fish bone and potash.	Machias.	4801
The Quinnipiac Co., New York City.	Market garden.	Hyde Park. Oswego Center.	4121 4930
The Quinnipiac Co., New York City.	Mohawk.	Canisteo. Andover. Walton.	4743 4763 5007
The Quinnipiac Co., New York City.	Plain superphosphate.	Canisteo.	4745

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	1.64	9	——	2	——	——
Found	2.08	9.24	12.12	3.50	1.05	3.31
Guaranteed	1.03	8	——	2	——	——
Found	1.08	8.33	10.46	1.96	0.34	4.49
Guaranteed	1.23	8	——	2	——	——
Found	1.34	8.32	11.45	2.21	0.75	3.49
Guaranteed	3.30	3	——	3	——	——
Found	3.14	3.69	9.31	3.58	0.25	1.55
Guaranteed	——	10	——	2	——	——
Found		10.54	13.05	1.97		4.08
Guaranteed	1.65	9	——	1	——	——
Found	1.92	9.39	13.17	1.15	0.50	1.55
Guaranteed	3.30	8	——	7	——	——
Found	3.25	9.52	11.26	6.97	1.86	4.46
Guaranteed	0.82	7	——	1	——	——
Found	1.23	7.40	9.51	1.15	0.55	1.35
Guaranteed	——	10	——	——	——	——
Found		11.89	13.81			6.67

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
The Quinnipiac Co., New York City.	Potato manure.	Hyde Park.	4119
The Quinnipiac Co., New York City.	Potato phosphate.	Machias. Oswego Center.	4802 4932
The Quinnipiac Co., New York City.	Soluble dissolved bone.	Machias. Walton.	4804 5008
The Quinnipiac Co., New York City.	Special formula.	Bayside.	4103
The Quinnipiac Co., New York City.	Special formula.	Hyde Park.	4120
The Quinnipiac Co., New York City.	Uncas bone meal.	Big Tree.	5043
Rasin Fertilizer Co., Baltimore, Md.	Acid phosphate.	Penn Yan.	4948
Rasin Fertilizer Co., Baltimore, Md.	Sulphate of potash.	Penn Yan.	5143
Read Fertilizer Co., New York City.	Acid phosphate.	Syracuse.	4264

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	2.47	6	——	5	——	——
Found	2.61	6.86	8.44	5.98	1.35	2.52
Guaranteed	2.06	8	——	3	——	——
Found	2.12	9.48	12.70	2.98	0.41	3.08
Guaranteed	——	13	——	——	——	——
Found		15	16.31			10.58
Guaranteed	3.70	8	——	8	——	——
Found	3.55	9.42	11.80	7.87	1.88	3.39
Guaranteed	3	7	——	7	——	——
Found	3.90	8.89	10.85	7	2.44	3.86
Guaranteed	1.65	——	13.50	——	——	——
Found	1.86		18.28		0.24	
Guaranteed	——	14	——	——	——	——
Found		15.21	16.21			11.11
Guaranteed	——	——	——	22.50	——	——
Found				20.60		
Below guarantee				1.90		
Guaranteed	——	10	——	——	——	——
Found		14.98	15.29			9.32

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Read Fertilizer Co., New York City.	Bone and potash.	Syracuse. Carthage.	4258 4877
Read Fertilizer Co., New York City.	Cabbage special.	Stanley.	4943
Read Fertilizer Co., New York City.	Dissolved bone phosphate.	Syracuse.	4262
Read Fertilizer Co., New York City.	Farmers' friend superphosphate.	Syracuse. Oneida. Brant.	4268 4429 5060
Read Fertilizer Co., New York City.	Fish, bone and potash.	Syracuse.	4261
Read Fertilizer Co., New York City.	High-grade farmer's friend.	Syracuse. Carthage.	4260 4878
Read Fertilizer Co., New York City.	High-grade farmer's friend for Long Island.	Mattituck.	4139
Read Fertilizer Co., New York City.	High-grade special.	Stanley.	4942
Read Fertilizer Co., New York City.	Leader guano.	Syracuse. Wyoming. East Aurora.	4263 4687 4835

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	——	8	——	4	——	——
Found		7.99	9.26	4.31		3.89
Guaranteed	2.47	6	——	8	——	——
Found	2.34	6	7.69	7.87	1.02	4.65
Guaranteed	——	12	——	——	——	——
Found		14.38	15.27			8.87
Guaranteed	2	9	——	2	——	——
Found	2.21	9.80	11.07	2.34	0.44	7.74
Guaranteed	2.50	4	——	4	——	——
Found	2.69	5.52	6.31	4.23	0.44	2.33
Guaranteed	3.25	5	——	10	——	——
Found	3.27	5.40	7.19	10.05	0.67	4
Guaranteed	3.30	7	——	7	——	——
Found	3.41	7.46	8.82	7.60	0.46	5.71
Guaranteed	2.47	7	——	15	——	——
Found	2.22	7.08	8.94	13.40	0.98	4.72
Below guarantee	0.25			1.60		
Guaranteed	0.83	7	——	2	——	——
Found	1.06	7.66	8.70	2.20	0.14	4.84

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Read Fertilizer Co., New York City.	N. Y. State superphosphate.	Syracuse.	4267
Read Fertilizer Co., New York City.	Original alkaline bone.	Syracuse. Holland. Brant.	4270 4823 5059
Read Fertilizer Co., New York City.	Potato special manure.	Syracuse. Carthage. Brant.	4257 4879 5057
Read Fertilizer Co., New York City.	Practical potato special.	Syracuse. Holland. Gowanda.	4256 4821 5082
Read Fertilizer Co., New York City.	Prime wheat and rye.	Syracuse. Wyoming. Rushville.	4266 4688 5211
Read Fertilizer Co., New York City.	Pure ground bone.	Syracuse. Holland.	4271 4824
Read Fertilizer Co., New York City.	Samson fertilizer.	Syracuse. Holland.	4259 4822
Read Fertilizer Co., New York City.	Standard superphosphate.	Syracuse. Oneida. Wyoming.	4269 4428 4689
Read Fertilizer Co., New York City.	Strawberry special.	Brant.	5058

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	1.20	9	——	2	——	——
Found	1.45	9.94	10.89	2.10	0.41	7.85
Guaranteed	——	10	——	3	——	——
Found		10.46	11.47	2.87		6.63
Guaranteed	2.47	7	——	10	——	——
Found	2.56	7.81	8.12	10.08	1.81	5.44
Guaranteed	0.83	4	——	8	——	——
Found	1.07	5.09	5.65	8.02	0.16	2.84
Guaranteed	1.64	8	——	4	——	——
Found	1.86	8.17	9.32	3.91	0.52	6.41
Guaranteed	2.50	——	22	——	——	——
Found	2.51		23.84		0.53	
Guaranteed	1.65	6	——	4	——	——
Found	1.94	7.12	8.24	4.35	0.40	4.70
Guaranteed	0.83	8	——	4	——	——
Found	1.04	8.84	9.65	4.08	0.17	6.06
Guaranteed	3.30	5	——	6	——	——
Found	2.81	5.29	7.22	7.42	0.49	3.06
Below guarantee	**0.49**					

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Read Fertilizer Co., New York City.	Vegetable and vine fertilizer.	Syracuse. Carthage.	4265 4876
John S. Reese & Co., Baltimore, Md.	Ammoniated bone phosphate mixture.	Penn Yan.	5152
John S. Reese & Co., Baltimore, Md.	Challenge corn grower.	Binghamton. Owego.	4341 5013
John S. Reese & Co., Baltimore, Md.	Dissolved phosphate of lime.	Owego.	5014
John S. Reese & Co., Baltimore, Md.	Elm phosphate.	Tully. Franklinville.	4294 4791
John S. Reese & Co., Baltimore, Md.	Half and half.	Penn Yan.	5150
John S. Reese & Co., Baltimore, Md.	Pilgrim fertilizer.	Tully. New City.	4296 4968
John S. Reese & Co., Baltimore, Md.	Potato phosphate.	New City. Owego.	4969 5015
John S. Reese & Co., Baltimore, Md.	Potato special.	Tully. Owego.	4295 5016

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

	In 100 Pounds of Fertilizer.					
	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	1.65	6	——	8	——	——
Found	1.95	6.34	8.13	8.38	0.48	4.68
Guaranteed	0.82	10	——	3	——	——
Found	0.80	11.03	11.96	2.86	0.44	0.62
Guaranteed	0.82	8.50	——	2	——	——
Found	0.90	11.61	13.23	1.82	0.45	0.58
Guaranteed	——	14	——	——	——	——
Found		15.59	15.90			9.55
Guaranteed	——	14	——	——	——	——
Found		14.16	14.59			8.11
Guaranteed	0.82	8	——	1	——	——
Found	1	12.82	14.07	0.42	0.22	2.21
Below guarantee				0.58		
Guaranteed	1.23	6.50	——	3	——	——
Found	1.53	9.28	11.07	2.82	0.38	0.36
Guaranteed	2.06	8.50	——	6	——	——
Found	2.47	8.48	9.73	6.61	0.80	0.72
Guaranteed	2.88	6.50	——	7.50	——	——
Found	1.26	9.48	10.83	5.98	0.39	2.18
Below guarantee	1.62			1.52		

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Rochester Fertilizer Works, Rochester, N. Y.	Blood and bone guano.	Livonia Sta.	4575
Rochester Fertilizer Works, Rochester, N. Y.	Genesee guano.	Livonia Sta.	4573
Rochester Fertilizer Works, Rochester, N. Y.	Pure ground bone.	Livonia Sta.	4574
Rochester Fertilizer Works, Rochester, N. Y.	Vegetable phosphate.	Livonia Sta.	4576
Rogers & Hubbard Co., Middletown, Conn.	Raw knuckle bone flour.	Orient.	4155
Rogers & Hubbard Co., Middletown, Conn.	Soluble potato manure.	Orient.	4154
Lucien Sanderson, New Haven, Conn.	Early cabbage manure.	Jamaica.	4069
Lucien Sanderson, New Haven, Conn.	Formula A.	Jamaica.	4068

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

IN 100 POUNDS OF FERTILIZER.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	0.82	8	——	1.62*	——	——
Found	0.90	9.81	10.69	2.32	0.26	5.12
Guaranteed	1.65	8	——	3.25*	——	——
Found	1.75	10.28	11.30	3.97	1.01	6.45
Guaranteed	3.69	——	24	——	——	——
Found	3.38		26.07		1.12	
Below guarantee	0.31					
Guaranteed	0.41	8	——	8*	——	——
Found	0.74	9.71	10.09	7.27	0.31	6.76
Below guarantee				0.73		
Guaranteed	3.50	——	24.50	——	——	——
Found	3.52		25.54		0.14	
Guaranteed	5	7	——	5*	——	——
Found	4.58	5.84	9.79	6.22	2.20	1.31
Below guarantee	0.42	1.16				
Guaranteed	4.10	5	——	5	——	——
Found	4.15	7.98	10.07	4.94	2.46	4.86
Guaranteed	3.29	7	——	6*	——	——
Found	3.44	8.89	10.01	5.63	1.89	5.98
Below guarantee				0.37		

* Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Lucien Sanderson, New Haven, Conn.	Potato fertilizer.	E. Williston.	4111
Scheid & Fechter, Buffalo, N. Y.	East star fertilizer.	N. Boston.	4841
Scientific Fertilizer Co., Pittsburg, Pa.	Corn and grain fertilizer.	Big Flats.	5187
H. C. Sherman, Penn Yan, N. Y.	Dissolved bone fertilizer.	Penn Yan.	5145
M. L. Shoemaker & Co., Philadelphia, Pa.	Swift sure bone meal.	Southampton.	4185
M. L. Shoemaker & Co., Philadelphia, Pa.	Swift sure superphosphate for potatoes.	Southampton.	4186
Isaac Smith, Columbiaville, N. Y.	Eureka.	Columbiaville	4229
Isaac Smith, Columbiaville, N. Y	Excelsior.	Columbiaville	4230
Isaac Smith, Columbiaville, N. Y.	Potato fertilizer.	Columbiaville	4231

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

IN 100 POUNDS OF FERTILIZER.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	3.29	7	—	6	—	—
Found	3.15	7.92	11.58	6.16	1.21	3.81
Guaranteed	5.38	4.15	—	1.31	—	—
Found	5.55	7.16	11.35	0.73	2.35	
Below guarantee				0.58		
Guaranteed	1.50	7.75	—	2	—	—
Found	2.15	6.46	8.53	2.55	0.45	2.10
Below guarantee		1.29				
Guaranteed	—	14	—	—	—	—
Found		13.98	16.28			7.97
Guaranteed	4	—	20	—	—	—
Found	5.93		21.95		1.78	
Guaranteed	2.50	8	—	6	—	—
Found	2.37	9.25	13.49	7.04	1.34	7.10
Guaranteed	0.75	5	—	2	—	—
Found	0.96	10.02	12.60	2.64	0.38	6.92
Guaranteed	1	7	—	2	—	—
Found	0.97	8.64	13.85	2.48	0.57	2.92
Guaranteed	2	4	—	4	—	—
Found	2.67	5.78	9.96	6	1.85	1.84

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Isaac Smith, Columbiaville, N. Y.	Special grade.	Columbiaville	4228
Isaac Smith, Columbiaville, N. Y.	Superphosphate.	Columbiaville	4227
Standard Fertilizer Co., Boston, Mass.	Ammoniated dissolved bone.	Nelson. Jamestown.	4417 5093
Standard Fertilizer Co., Boston, Mass.	A brand.	Nelson. Voorheesville Jamestown.	4416 4491 5092
Standard Fertilizer Co., Boston, Mass.	Bone and potash.	Nelson.	4418
Standard Fertilizer Co., Boston, Mass.	Complete manure.	Bridgehampton.	4171
Standard Fertilizer Co., Boston, Mass.	Dissolved bone.	Voorheesville	4490
Standard Fertilizer Co., Boston, Mass.	Extra fine ground bone.	North Collins.	5069
Standard Fertilizer Co., Boston, Mass.	Guano.	Scott.	4299
Standard Fertilizer Co., Boston, Mass.	Lawn dressing.	Albany.	4489

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

IN 100 POUNDS OF FERTILIZER.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	3	4	——	9	——	——
Found	3.07	8.81	12.19	10.38	2.04	3.02
Guaranteed	2	4	——	1	——	——
Found	2.51	6.21	9.55	2.22	1.99	2.51
Guaranteed	1.64	9	——	2	——	——
Found	1.67	8.80	10.84	2.33	0.53	6.72
Guaranteed	0.82	7	——	1	——	——
Found	1.02	9.53	11.25	1.76	0.30	6.41
Guaranteed	——	8	——	2.50	——	——
Found		9.19	10.46	2.30		6.04
Guaranteed	3.30	8	——	7	——	——
Found	3.25	8.71	11.41	7.12	1.62	2.94
Guaranteed	——	10	——	——	——	——
Found		11.36	14.05			8.24
Guaranteed	1.65	14	——	——	——	——
Found	2.28	14.43			0.66	
Guaranteed	1.03	8	——	2	——	——
Found	1.16	8.91	10.64	2.34	0.30	6.16
Guaranteed	4.95	5	——	2.50*	——	——
Found	4.84	5.88	7.50	2.77	3.82	1.62

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Standard Fertilizer Co., Boston, Mass.	L. I. club formula.	Riverhead.	4127
Standard Fertilizer Co., Boston, Mass.	Potato and tobacco fertilizer.	Camden.	4914
Standard Fertilizer Co., Boston, Mass.	Special for potatoes.	Gorham.	5221
H. Stappenbeck, Utica, N. Y.	Bone meal.	Utica.	4445
H. Stappenbeck, Utica, N. Y.	Home-trade bone superphosphate.	Utica. Clinton.	4443 4541
H. Stappenbeck, Utica, N. Y.	Hop, fruit and vegetable special.	Utica. Remsen.	4444 4868
Geo. Stevens, Peterborough, Ont., Can.	Canada unleached hardwood ashes.	East Marion. Horseheads.	4146 5174
Swift & Co., Chicago, Ill.	Bone and potash.	Cuba.	4770

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	4	8	——	10	——	——
Found	3.60	8.63	10.37	9.87	1.60	4.86
Below guarantee	0.40					
Guaranteed	2.05	8	——	3	——	——
Found	2.34	8.66	12.05	2.65	0.49	4.82
Below guarantee				0.35		
Guaranteed	2.05	8	——	3	——	——
Found	2.15	8.75	11.90	3.32	0.84	5.47
Guaranteed	3.30	——	20	——	——	——
Found	3.53		23.83		1.93	
Guaranteed	2.05	8	——	2	——	——
Found	2.70	12.85	14.25	2.02	1.27	6.37
Guaranteed	2.05	8	——	6*	——	——
Found	1.95	10.49	11.94	6.10	0.76	5.20
Guaranteed	——	——	1.50	5*	——	——
Found			1.50	3.66		
Below guarantee				1.34		
Guaranteed	2	——	24.5	6*	——	——
Found	2.32		24.57	5.34	0.32	
Below guarantee				0.66		

* Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Swift & Co., Chicago, Ill.	Bone, tankage and potash.	Wellsville.	4767
Swift & Co., Chicago, Ill.	Ground steamed bone.	Oneonta.	4510
Swift & Co., Chicago, Ill.	No. 2 ground tankage.	Fredonia.	5125
Swift & Co., Chicago, Ill.	Potato and tobacco grower.	Oneonta.	4505
Swift & Co., Chicago, Ill.	Pure bone and potash.	Oneonta. Cuba.	4509 4769
Swift & Co., Chicago, Ill.	Pure bone superphosphate.	Oneonta.	4504
Swift & Co., Chicago, Ill.	Raw bone meal.	Oneonta. Fredonia.	4508 5124
C. R. Sworts, Dundee, N. Y.	Alkaline dissolved bone.	Dundee.	5170

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	5	——	17	3	——	——
Found	4.39		18.58	2.69	2.16	
Below guarantee	0.61			0.31		
Guaranteed	2.90	——	26	——	——	——
Found	2.89		26.80		0.39	
Guaranteed	5.75	——	10	——	——	——
Found	5.72	5.74	12.93		0.94	
Guaranteed	3.30	10	——	5*	——	——
Found	3.71	9.17	12.32	4.65	0.51	5.95
Below guarantee		0.83		0.35		
Guaranteed	2	——	24.50	3*	——	——
Found	3.23		24.81	3.02	0.42	
Below guarantee						
Guaranteed	2.20	8	——	2*	——	——
Found	2.64	8.57	13.08	1.13	0	5.71
Below guarantee				0.87		
Guaranteed	3.75	——	23	——	——	——
Found	3.87		23.85		0.37	
Guaranteed	——	13	——	3	——	——
Found		13.44	14.28	3.32		10.39

* Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
C. R. Sworts, Dundee, N. Y.	Dissolved bone.	Dundee.	5169
C. R. Sworts, Dundee, N. Y.	Special guano.	Dundee.	5171
I. P. Thomas & Son Co., Philadelphia, Pa.	Improved super-phosphate.	East Avon. Binghamton. Florida.	4594 4339 4982
I. P. Thomas & Son Co., Philadelphia, Pa.	Normal bone.	East Avon.	4596
I. P. Thomas & Son Co., Philadelphia, Pa.	Onion manure.	Florida.	4981
I. P. Thomas & Son Co., Philadelphia, Pa.	Potato fertilizer.	Calverton.	4130
I. P. Thomas & Son Co., Philadelphia, Pa.	Potato manure.	East Avon.	4593
I. P. Thomas & Son Co., Philadelphia, Pa.	Special corn.	East Avon.	4592
I. P. Thomas & Son Co., Philadelphia, Pa.	Special onion manure.	East Avon.	4595

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

IN 100 POUNDS OF FERTILIZER.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	——	14	——	——	——	——
Found		14.68	16.13			9.96
Guaranteed	0.82	8	——	4	——	——
Found	1	9.67	9.88	4.17	0.28	4.69
Guaranteed	1	10	——	1	——	——
Found	1.11	10.43	12.75	1.28	0.40	1.36
Guaranteed	1.50	8.50	——	1.50	——	——
Found	1.45	9.44	11.48	2.47	0.58	7.14
Guaranteed	1.65	7	——	5	——	——
Found	1.70	9.50	9.84	6.69	1.02	7.13
Guaranteed	2	9	——	6	——	——
Found	1.67	9.71	10.01	6.60	1	7.65
Below guarantee	0.33					
Guaranteed	2.75	9	——	6	——	——
Found	2.39	10.78	11.07	7.07	1.01	9.28
Below guarantee	0.36					
Guaranteed	——	10	——	6.50*	——	——
Found		13.74	14.42	7.52		9.41
Guaranteed	1.60	7	——	5	——	——
Found	1.50	9.38	9.95	6.51	0.80	7.56

* Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
I. P. Thomas & Son Co., Philadelphia, Pa.	Special potato fertilizer.	Binghamton.	4342
I. P. Thomas & Son Co., Philadelphia, Pa.	Tip top raw bone superphosphate.	Binghamton.	4340
Henry F. Tucker & Co., Boston, Mass.	High-grade potato, tobacco and vegetable manure.	Billsborough.	5234
Henry F. Tucker & Co., Boston, Mass.	Imperial bone superphosphate.	Salamanca. Dunkirk. Billsborough.	5101 5121 5236
Henry F. Tucker & Co., Boston, Mass.	Original Bay State bone superphosphate.	Billsborough.	5235
E. Tuthill & Co., Promised Land, N. Y.	Acid fish.	Promised Land.	4183
E. Tuthill & Co., Promised Land, N. Y.	Acid phosphate.	Promised Land.	4184
E. Tuthill & Co., Promised Land, N. Y.	Corn fertilizer.	Promised Land.	4181
E. Tuthill & Co., Promised Land, N. Y.	Fish scrap.	New Suffolk.	4163

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	3	9	——	6	——	——
Found	3.01	8.81	10.16	7.55	0.97	6.17
Guaranteed	2.47	10	——	2.75	——	——
Found	3.16	9.81	12.41	3.68	0.83	6.97
Guaranteed	2.06	9	——	3	——	——
Found	2.08	10.19	11.91	3.14	0.89	6.46
Guaranteed	1.03	8	——	2.15	——	——
Found	1.16	8.48	10.29	2.20	0.42	5.57
Guaranteed	1.64	9	——	2	——	——
Found	1.67	9.70	11.01	2.06	0.56	6.23
Guaranteed	5	4	——	——	——	——
Found	5.35	3.57	3.84		0.95	0.97
Below guarantee		0.43				
Guaranteed	——	19	——	——	——	——
Found		20.64	20.84			15.55
Guaranteed	5	8	——	5	——	——
Found	4.89	6.94	9.19	6.63	0.89	3.82
Below guarantee		1.06				
Guaranteed	8	——	6	——	——	——
Found	8.69	4.66	7.23		0.44	

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
E. Tuthill & Co., Promised Land, N. Y.	Jones' fertilizer.	Promised Land.	4179
E. Tuthill & Co., Promised Land, N. Y.	Northport club fertilizer.	Promised Land.	4180
E. Tuthill & Co., Promised Land, N. Y.	No. 1.	Promised Land.	4175
E. Tuthill & Co., Promised Land, N. Y.	No. 2.	Promised Land.	4176
E. Tuthill & Co., Promised Land, N. Y.	No. 3.	Promised Land.	4177
E. Tuthill & Co., Promised Land, N. Y.	No. 4.	Promised Land.	4178
E. Tuthill & Co., Promised Land, N. Y.	Riverhead Town club fertilizer.	Riverhead.	4126
E. Tuthill & Co., Promised Land, N. Y.	Southold Town club fertilizer.	Southold.	4158
E. Tuthill & Co., Promised Land, N. Y.	Special potato fertilizer.	E. Williston.	4113

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	4	8	———	10	———	———
Found	3.81	8.74	9.04	11.02	1.71	7.14
Guaranteed	4	8	———	10	———	———
Found	4	9.02	9.53	10.49	1.90	6.72
Guaranteed	4	8	———	10	———	———
Found	4.83	7.17		9.37	0.65	4.75
Below guarantee		0.83		0.63		
Guaranteed	4	5	———	7	———	———
Found	4.32	4.95	6.76	7.07	0.14	2.89
Guaranteed	3	7	———	9	———	———
Found	3.71	7.45	8.47	8.43	0.37	5.12
Below guarantee				0.57		
Guaranteed	3	7	———	7	———	———
Found	3.40	6.80	7.87	7.91		4.50
Guaranteed	4	8	———	10	———	———
Found	4.06	8.65	9.23	10.54	2.34	7
Guaranteed	4	8	———	10	———	———
Found	3.90	8.40	9.55	10.39	0.22	5.32
Guaranteed	4	8	———	10	———	———
Found	4.18	8.89	9.24	9.99	0.58	5.38

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
E. Tuthill & Co., Promised Land, N. Y.	Webb's fertilizer.	New Suffolk.	4164
E. Tuthill & Co., Promised Land, N. Y.	Wines & Lupton fertilizer.	Promised Land.	4182
J. E. Tygert Co., Philadelphia, Pa.	Cabbage manure.	Jamaica.	4095
J. E. Tygert Co., Philadelphia, Pa.	Potato guano.	Mineola.	4116
J. E. Tygert Co., Philadelphia, Pa.	Truckers' potato guano.	Jamaica.	4094
Tygert-Allen Fertilizer Co., Philadelphia, Pa.	Potato manure.	Sagaponack.	4173
Tygert-Allen Fertilizer Co., Philadelphia, Pa.	Prairie bone.	Fredonia.	5132
Tygert-Allen Fertilizer Co., Philadelphia, Pa.	Star bone phosphate.	Fredonia.	5129

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	3	7	——	9	——	——
Found	3.35	7.11	8.81	9.77	0.24	5.01
Guaranteed	4	8	——	10	——	——
Found	3.90	8.92	9.31	9.24	1.67	6.58
Below guarantee				0.76		
Guaranteed	2.50	7	——	5	——	——
Found	2.21	7.99	9.40	5.01	1.34	4.98
Below guarantee	0.29					
Guaranteed	2	7	——	7	——	——
Found	1.98	8.64	10.04	6.57	0.61	6.59
Below guarantee				0.43		
Guaranteed	3.31	7	——	9	——	——
Found	2.61	7.21	9.56	9.98	1.55	4.06
Below guarantee	0.70					
Guaranteed	3.30	6	——	9	——	——
Found	3	6.16	7.78	9.24	1.99	3.54
Below guarantee	0.30			0.76		
Guaranteed	2.49	——	18	——	——	——
Found	3.09		18.08		0.43	
Guaranteed	1.85	8.50	——	2.50	——	——
Found	2.03	8.42	9.91	2.84	0.68	7.11

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Tygert-Allen Fertilizer Co., Philadelphia, Pa.	Star guano.	Fredonia.	5128
Tygert-Allen Fertilizer Co., Philadelphia, Pa.	Standard bone phosphate.	Fredonia.	5131
Tygert-Allen Fertilizer Co., Philadelphia, Pa.	Tankage.	Italy Hill.	5202
Tygert-Allen Fertilizer Co., Philadelphia, Pa.	Truckers' triumph potato guano.	Fredonia.	5130
F. G. Underwood, Oneida, N. Y.	Bone meal.	Oneida.	4430
F. G. Underwood, Oneida, N. Y.	High grade fertilizer.	Oneida.	4419
F. G. Underwood, Oneida, N. Y.	Tankage.	Oneida.	4431
J. W. Van Cott & Son, Unadilla, N. Y.	Corn special.	Unadilla.	4532

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

IN 100 POUNDS OF FERTILIZER.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	2.26	7.50	——	3.50	——	——
Found	1.75	7.98	9.62	3.39	1.04	5.79
Below guarantee	0.51					
Guaranteed	1.65	8	——	2	——	——
Found	1.69	8.17	9.85	4.32	0.85	5.61
Guaranteed	8	——	——	——	——	——
Found	7.09		2.79		1.42	
Below guarantee	0.91					
Guaranteed	3.30	7	——	8.50	——	——
Found	3.10	5.92	7.88	8.30	1.95	3.38
Below guarantee		1.08				
Guaranteed	1	——	10	——	——	——
Found	3.15		20.68		1.34	
Guaranteed	2.60	7	——	7	——	——
Found	2.40	6.71	12.03	7.09	1.17	3.18
Below guarantee		0.29				
Guaranteed	1	2	4	——	——	——
Found	4.77	5.27	10.41		1.98	
Guaranteed	2.06	8	——	3	——	——
Found	2.18	8.88	9.79	3.42	1.24	5.05

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
J. W. Van Cott & Son, Unadilla, N. Y.	Oats and buckwheat standard.	Unadilla.	4533
Walker Fertilizer Co., Clifton Springs, N. Y.	Chemung Valley special.	Horseheads.	5173
Walker Fertilizer Co., Clifton Springs, N. Y.	Clifton.	Reeds Corners.	4945
Walker Fertilizer Co., Clifton Springs, N. Y.	Onion special.	Florida.	4977
Walker Fertilizer Co., Clifton Springs, N. Y.	Potato and vegetable grower.	Reeds Corners.	4944
Walker Fertilizer Co., Clifton Springs, N. Y.	Wheat special No. 2.	Dresden.	5162
W. E. Whann, William Penn, Pa.	Chester Valley special.	E. Corning.	5182
M. E. Wheeler & Co., Rutland, Vt.	Corn fertilizer.	Oxford. Haverstraw. Pavilion.	4372 4962 5111
M. E. Wheeler & Co., Rutland, Vt.	Electrical dissolved bone.	Leroy. Pearl Creek. Bath.	4675 4696 5188

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

IN 100 POUNDS OF FERTILIZER.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	0.82	8	——	4	——	——
Found	0.83	9.30	10.83	4.06	0.45	6.18
Guaranteed	1.50	7	——	8	——	——
Found	1.66	9.93	12.08	9.43	0.15	2.62
Guaranteed	2.47	10	——	2.50	——	——
Found	2.34	9.96	10.99	2.45	0.14	5.49
Guaranteed	2.47	7	——	8	——	——
Found	2.50	9.36	10.58	7.87	0.27	5.86
Guaranteed	2.47	6	——	7	——	——
Found	2.47	6.17	6.82	6.72	0.04	2.93
Below guarantee				0.28		
Guaranteed	1.65	11	——	5	——	——
Found	1.62	12.50	13.60	4.47	0.11	8.35
Below guarantee				0.53		
Guaranteed	2.25	8	——	5	——	——
Found	2.46	8.21	9.63	5.81	0.90	5.51
Guaranteed	1.64	8	——	2	——	——
Found	1.89	11.10	12.54	2.20	0.29	1.18
Guaranteed	——	13	——	——	——	——
Found		14.74	15.23			11.27

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
M. E. Wheeler & Co., Rutland, Vt.	Grass and oats.	Vanhornsville. Haverstraw.	4454 4961
M. E. Wheeler & Co., Rutland, Vt.	High grade fruit fertilizer.	Tallmans. North Collins.	4974 5052
M. E. Wheeler & Co., Rutland, Vt.	High-grade Orleans Co. bean manure.	Pearl Creek. Pavilion.	4697 5114
M. E. Wheeler & Co., Rutland, Vt.	High-grade royal sweet potato manure.	Pavilion.	5113
M. E. Wheeler & Co., Rutland, Vt.	Potato manure.	Oxford. Vanhornsville. Pavilion.	4371 4453 5112
M. E. Wheeler & Co., Rutland, Vt.	Royal wheat grower.	Leroy. Pearl Creek.	4674 4699
Wilcox Fertilizer Works, Mystic, Conn.	Dry ground fish guano.	Orient.	4147
Williams & Clark Fertilizer Co., New York City.	Acorn acid phosphate.	Amsterdam. Brant.	4467 5054
Williams & Clark Fertilizer Co., New York City.	Ammoniated bone superphosphate.	White Plains.	4204

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

	In 100 Pounds of Fertilizer.					
	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed Found	———	11 12.38	——— 15.02	2 2.34	———	——— 5.84
Guaranteed Found Below guarantee	———	10 10.76	——— 11.09	8 7.07 0.93	———	——— 6.95
Guaranteed Found	0.82 0.97	8 8.39	——— 8.87	4 4.34	——— 0.56	——— 4.97
Guaranteed Found Below guarantee	2 2	8 8.26	——— 9.07	8 4.59 3.41	——— 0.53	——— 5.47
Guaranteed Found	2.05 2.41	8 11.17	——— 12.47	3.25 3.30	——— 1.61	——— 2.48
Guaranteed Found	0.82 1.02	8 11.52	——— 12.84	2 1.84	——— 0.37	——— 0.48
Guaranteed Found	8.50 9	4 4.53	6 6.54	———	——— 0.42	———
Guaranteed Found	———	13 14.48	——— 16.26	———	———	——— 11.38
Guaranteed Found	2.47 2.93	9 9.34	——— 12.65	2 1.86	——— 0.83	——— 5.06

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Williams & Clark Fertilizer Co., New York City.	Ammoniated dissolved bone.	Whitney Pt. Franklin Iron Works. Collins.	4334 4849 5076
Williams & Clark Fertilizer Co., New York City.	Carteret ground bone.	Brant.	5056
Williams & Clark Fertilizer Co., New York City.	Dissolved bone and potash.	Franklin Iron Works. Williamst'wn Cassadaga.	4540 4910 5240
Williams & Clark Fertilizer Co., New York City.	Good grower potato phosphate.	Amsterdam. Andover. Williamst'wn	4469 4759 4908
Williams & Clark Fertilizer Co., New York City.	High-grade special.	White Plains.	4203
Williams & Clark Fertilizer Co., New York City.	Potato, hop and tobacco.	Franklin Iron Works.	4850
Williams & Clark Fertilizer Co., New York City.	Potato phosphate.	Jamaica. Franklinville. Cassadaga.	4077 4783 5241
Williams & Clark Fertilizer Co., New York City.	Prolific crop producer.	Hudson. Andover. Williamst'wn	4233 4760 4909

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	1.64	8	——	2*	——	——
Found	1.90	9.54	13.06	2.12	0.51	4.87
Guaranteed	1.64	——	14	——	——	——
Found	2.04	4.77	18.11		0.49	
Guaranteed	——	10	——	2	——	——
Found		10.88	12.52	1.80		7.34
Guaranteed	1.23	6	——	5	——	——
Found	1.49	6.85	9.72	4.95	0.73	1.90
Guaranteed	3.30	8	——	7	——	——
Found	3.20	9.47	11.57	7.30	1.67	4.08
Guaranteed	2	8	——	3	——	——
Found	2.28	10.62	13.28	3.40	1.11	2.50
Guaranteed	2.50	6	——	5	——	——
Found	2.54	7.51	8.96	5.88	1.39	2.56
Guaranteed	0.82	6	——	1	——	——
Found	1.03	8.33	10.58	1.13	0.51	3.18

* Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Williams & Clark Fertilizer Co., New York City.	Royal bone phosphate.	Jamaica. Whitney Pt. Franklinville.	4078 4333 4780
Willoughby & Fletcher, Oxford, N. Y.	Grain and grass.	Oxford.	4363
Willoughby & Fletcher, Oxford, N. Y.	Grain and grass.	Oxford.	4364
Willoughby & Fletcher, Oxford, N. Y.	High-grade guano for potatoes and vegetables.	Oxford.	4362
Zell Guano Co., Baltimore, Md.	Ammoniated bone superphosphate.	Carthage. Waverly. Gorham.	4881 5037 5223
Zell Guano Co., Baltimore, Md.	Calvert guano.	Carthage. Watertown.	4882 4895
Zell Guano Co., Baltimore, Md	Corn and potato manure.	Newark Valley.	5019
Zell Guano Co., Baltimore, Md.	Dissolved bone phosphate.	Warsaw. Waverly. Prattsburg.	4707 5038 5193
Zell Guano Co., Baltimore, Md.	Dissolved S. C. phosphate.	Warsaw. Hamburg. Prattsburg.	4709 4847 5192

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

	In 100 Pounds of Fertilizer.					
	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	1.03	7	——	2*	——	——
Found	1.37	9.43	10.90	2.27	0.62	5.94
Guaranteed	0.82	9	——	2	——	——
Found	0.81	9.12	10.79	2.38	0.38	5.83
Guaranteed	1.03	8	——	2	——	——
Found	1.15	9.20	10.79	2.28	0.08	7
Guaranteed	0.82	9	——	2	——	——
Found	0.68	9.20	10.78	2.31	0.27	6.14
Guaranteed	1.60	8	——	2	——	——
Found	1.83	9.92	11.07	2.51	0.28	8.31
Guaranteed	0.60	9	——	1.50	——	——
Found	0.80	10.84	11.73	2.18	0	9.23
Guaranteed	1.65	6	——	4	——	——
Found	2.03	7.22	9.33	4.06	1.08	3.06
Guaranteed	——	14	——	——	——	——
Found		14.62	16.58			11.86
Guaranteed	——	13	——	——	——	——
Found		13.87	16.11			11.73

* Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Zell Guano Co., Baltimore, Md.	Economizer.	Warsaw. Waverly. Prattsburg.	4711 5036 5195
Zell Guano Co., Baltimore, Md.	Electric phosphate.	Summer Hill. Carthage. Dayton.	4317 4880 5089
Zell Guano Co., Baltimore, Md.	Fruit tree invigorator.	Warsaw. Hamburg. Prattsburg.	4710 5039 5194
Zell Guano Co., Baltimore, Md.	Genesee.	Warsaw. Watertown.	4708 4890
Zell Guano Co., Baltimore, Md.	High grade cabbage manure.	Watertown.	4894
Zell Guano Co., Baltimore, Md.	Pure ground raw bone.	Hamburg.	4848
Zell Guano Co., Baltimore, Md.	Special ammoniated bone.	Newark Valley.	5018
Zell Guano Co., Baltimore, Md.	Special compound for onions.	Lima.	4561
Zell Guano Co., Baltimore, Md.	Special compound for potatoes and vegetables.	Warsaw. Watertown.	4712 4891

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	0.80	9	——	2	——	——
Found	0.87	11.61	12.63	2.25	0.15	9
Guaranteed	——	10	——	2	——	——
Found		10.59	12.23	1.91		7.93
Guaranteed	——	10	——	8	——	——
Found		11.75	12.75	9.54		9.19
Guaranteed	2.05	8	——	2	——	——
Found	2.21	9.36	11.71	2.19	0.14	8.36
Guaranteed	4.10	6	——	6	——	——
Found	4.33	6.74	8.48	6.09	2.82	5.91
Guaranteed	3.25	——	20	——	——	——
Found	4.99		18.86		0.25	
Below guarantee			1.14			
Guaranteed	1.25	5	——	1.50	——	——
Found	2.51	5.58	7.68	1.81	1.67	1.68
Guaranteed	0.80	7	——	15	——	——
Found	0.90	9.67	10.25	13.98	0.03	7.08
Below guarantee				1.02		
Guaranteed	2.45	8	——	4	——	——
Found	2.47	11.18	12.41	4.01	1.28	9.10

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Zell Guano Co., Baltimore, Md.	Special fertilizer.	Marathon.	4323
Zell Guano Co., Baltimore, Md.	Special high-grade onion manure.	Lima.	4556
Zell Guano Co., Baltimore, Md.	Special high-grade potato manure.	Watertown.	4887
Zell Guano Co., Baltimore, Md.	Special high-grade wheat manure.	Dayton. Gorham.	5088 5222
Zell Guano Co., Baltimore, Md.	Tobacco fertilizer.	Waverly.	5034
Not given.	Garbage.	White Plains.	4208
Not given.	Cabbage fertilizer.	Jamaica.	4086
Not given.	High-grade fertilizer.	Jamaica.	4087

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

	In 100 Pounds of Fertilizer.					
	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	2.45	7	—	8	—	—
Found	2.44	9.26	10.33	8.24	0	7.62
Guaranteed	3.25	6	—	8	—	—
Found	3.40	8.23	10.09	8.25	0.31	5.93
Guaranteed	3.25	6	—	8	—	—
Found	3.21	7.74	9.83	8.22	0.21	6.62
Guaranteed	1.60	10	—	5	—	—
Found	1.67	11.06	12.41	5.04	0.19	9.49
Guaranteed	2.45	8	—	4	—	—
Found	2.23	11.71	12.97	3.65	1.14	9.09
Below guarantee	0.22			0.35		
Guaranteed	—	—	—	—	—	—
Found	5.01	1	1	0.13	1.70	
Guaranteed	4.12	6	—	8	—	—
Found	3.21	10.01	14.29	5.76	1.88	3.12
Below guarantee	0.91			2.24		
Guaranteed	3.29	8	—	7	—	—
Found	3.24	9.90	14.26	5.06	1.85	3.27
Below guarantee				1.94		

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Not given.	Newbold's summer king.	Southold.	4159
Not given.	Peach tree fertilizer.	Gardnertown	4246
Not given.	Potato special.	Jamaica.	4085

LECTED IN NEW YORK STATE DURING THE SPRING OF 1898.

IN 100 POUNDS OF FERTILIZER.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	3.25	7	—	7	—	—
Found	3.04	8.46	9.87	7.64	1.43	6.30
Below guarantee	0.21					
Guaranteed	2.67	—	12	1.36*	—	—
Found	2.66	5.69	12.18	1.94	0.71	2.69
Guaranteed	3.29	5	—	10	—	—
Found	3.08	9.73	14.76	5.12	1.74	3.44
Below guarantee	0.21			4.88		

* Potash present in form of sulphate.

II. REPORT OF ANALYSES OF COMMERCIAL FERTILIZERS FOR THE FALL OF 1898.*

L. L. Van Slyke.

SUMMARY.

(1) Samples Collected. During the fall of 1898, the Station collected 244 samples of commercial fertilizers, representing 162 different brands. Of these different brands 111 were complete fertilizers; of the others, 23 contained phosphoric acid and potash without nitrogen; 5 contained nitrogen and phosphoric acid without potash; 12 contained phosphoric acid alone; 5 contained potash salts only, and 6 contained nitrogen only.

(2) Nitrogen. The 111 brands of complete fertilizers contained nitrogen varying in amount from 0.46 to 4.69 per cent and averaging 1.67 per cent. The average amount of nitrogen found by the Station analysis exceeded the average guaranteed amount by 0.16 per cent, the guaranteed average being 1.51 per cent and the average found being 1.67 per cent.

In 84 brands of complete fertilizers, the amount of nitrogen found was equal to or above the guaranteed amount, the excess varying from 0.01 to 1.29 per cent and averaging 0.30 per cent.

In 26 brands, the nitrogen was below the guaranteed amount, the deficiency varying from 0.02 to 0.77 per cent and averaging 0.20 per cent. In 24 cases, the deficiency was less than 0.5 per cent.

The amount of water-soluble nitrogen varied from 0 to 3.02 per cent and averaged 0.54 per cent.

(3) Available Phosphoric Acid. The 111 brands of complete fertilizers contained available phosphoric acid varying in amount

* Reprint of Bulletin No. 148.

from 4.77 to 13.45 per cent and averaging 9.27 per cent. The average amount of available phosphoric acid found by the Station analysis exceeded the average guaranteed amount by 0.96 per cent, the guaranteed average being 8.31 per cent and the average found being 9.27 per cent.

In 93 brands of complete fertilizers, the amount of available phosphoric acid found was above the amount guaranteed, the excess varying from 0.09 to 4.62 per cent and averaging 1.24 per cent.

In 18 brands, the available phosphoric acid was below the guaranteed amount, the deficiency varying from 0.03 to 1.61 per cent and averaging 0.48 per cent. In 11 cases the deficiency was below 0.5 per cent.

The amount of water-soluble phosphoric acid varied from 0.62 per cent to 9.78 per cent, and averaged 5.72 per cent.

(4) Potash. The complete fertilizers contained potash varying in amount from 0.36 to 10.43 per cent and averaging 4.36 per cent. The average amount of potash found by the Station analysis exceeded the average guaranteed amount by 0.26 per cent, the guaranteed average being 4.10 per cent and the average found being 4.36 per cent.

In 79 brands of complete fertilizers, the amount of potash found was above the guaranteed amount, the excess varying from 0.01 to 2.87 per cent and averaging 0.57 per cent.

In 31 brands, the potash was below the guaranteed amount, the deficiency varying from 0.05 to 2.29 per cent and averaging 0.54 per cent. In 18 of these cases, the deficiency was less than 0.5 per cent.

In 11 cases among the 111 brands of complete fertilizers the potash was contained in the form of sulphate free from an excess of chlorides.

(5) The retail selling prices of the complete fertilizers varied from $14.25 to $35 a ton and averaged $23.16. The retail cost of the separate ingredients unmixed averaged $17.34, or $5.82 less than the selling price.

INTRODUCTION.

NUMBER AND KINDS OF FERTILIZERS COLLECTED.

During the entire year of 1898, we collected 1,427 samples of commercial fertilizers, representing 901 different brands. It is a matter of interest to notice to what extent dealers offer for sale complete fertilizers (those containing nitrogen, phosphoric acid and potash), compared with those containing only one or two of these ingredients. It is also of interest to consider the different forms in which incomplete fertilizers are offered for sale. The following tabulated statement indicates the different kinds of complete and incomplete fertilizers collected during the year.

CLASSES OF FERTILIZERS COLLECTED IN 1898.

1898.	Brands containing only nitrogen.	Brands containing only phosphoric acid	Brands containing only potash.	Brands containing nitrogen and phosphoric acid without potash.	Brands containing potash and phosphoric acid without nitrogen.	Brands of complete commercial fertilizers.
Spring collection.	8	44	7	47	55	578
Fall collection..	6	12	5	5	23	111
Total for year.	14	56	12	52	78	689

In the spring collection 78 per cent of the brands offered for sale consisted of complete fertilizers; in the fall, 68.5 per cent, and during the year an average of 76.5 per cent. Of unmixed materials, phosphoric acid was offered much more largely than nitrogen or potash, the average for the year being about 8 per cent of all brands offered. A smaller number containing phosphoric acid and nitrogen was found. It will be seen that the mixture of phosphoric acid and potash was quite largely used, averaging for the year over 11 per cent of all the brands collected.

COMPOSITION OF FERTILIZERS COLLECTED IN 1898.

The tabulated statement below shows the average composition of the complete fertilizers collected during the year, together with a comparison of the guaranteed composition and that found by analysis.

Average Composition of Complete Fertilizers Collected.

	Per Cent Guaranteed.			Per Cent Found			Average per cent. found above guarantee.
	Lowest.	Highest.	Average.	Lowest.	Highest.	Average.	
Spring.							
Nitrogen	0.40	8.78	2.06	0.12	8.21	2.20	0.14
Available phosphoric acid	3.00	14.00	7.65	3.69	14.28	8.65	1.00
Insoluble phosphoric acid	....	.....	....	0.00	10.75	1.90	....
Potash	0.50	15.00	4.67	0.22	15.22	4.91	0.24
Water-soluble phosphoric acid	....	.....	....	0.10	11.11	5.08	....
Water-soluble nitrogen	....	.....	....	.0	5.03	0.94	....
Fall.							
Nitrogen	0.41	5.38	1.51	0.46	4.69	1.67	0.16
Available phosphoric acid	4.00	11.00	8.31	4.77	13.45	9.27	0.96
Insoluble phosphoric acid	....	.....	....	0.21	4.50	1.89	....
Potash	1.00	19.00	4.10	0.36	10.43	4.36	0.26
Water-soluble phosphoric acid	....	.....	....	0.62	9.78	5.72	....
Water-soluble nitrogen	....	.....	....	.0	3.02	0.54	....
Average for year.							
Nitrogen	....	.....	1.97	....	.....	2.12	0.15
Available phosphoric acid	....	.....	7.76	....	.....	8.75	0.99
Insoluble phosphoric acid	....	.....	....	....	.....	1.90	....
Potash	....	.....	4.58	....	.....	4.82	0.24
Water-soluble phosphoric acid	....	.....	....	....	.....	5.04	....
Water-soluble nitrogen	....	.....	....	....	.....	0.88	....

AVERAGE COMPOSITION OF CHEMICALS AND INCOMPLETE FERTILIZERS.

	Per Cent Guaranteed.			Per Cent Found.			Average per cent found above guarantee.
	Lowest.	Highest.	Average.	Lowest.	Highest.	Average.	
Nitrogen in							
Nitrate of soda....	14.76	16.00	15.16	14.80	15.76	15.59	0.43
Sulphate of ammonia	.....	.....	20.	.....	.....	20.34	0.34
Dried blood	9.75	10.50	10.10	9.27	10.55	9.80	*0.30
Dissolved phosphates,							
Phosphoric acid							
Available	10.00	30.00	13.64	11.05	33.27	14.54	0.90
Water-soluble ...	.....	.....	.....	3.73	15.55	9.51	....
Insoluble	.....	.....	.....	0.	4.22	1.33	....
Potash in							
Kainit	12.40	12.48	12.44	11.94	17.36	13.48	1.08
Muriate	50.	50.40	50.20	49.74	53.20	50.92	0.72
Sulphate	.....	.....	22.50	.....	.....	20.60	....
Fish scrap							
Nitrogen	5.00	8.50	7.17	5.35	9.	7.68	0.51
Phosphoric acid....	4.00	6.00	5.34	3.84	7.23	5.20	....
Bone meal							
Nitrogen	1.00	4.00	2.50	1.05	4.77	2.95	0.45
Phosphoric acid....	9.00	26.67	19.10	10.93	28.83	21.32	2.22
Mixtures containing							
Phosphoric acid							
Available	8.00	13.00	10.25	7.46	14.22	11.00	0.75
Insoluble	.....	.....	.....	0.	9.50	2.35	....
Potash	1.00	10.00	3.65	0.84	9.85	3.80	0.15

TRADE VALUES OF PLANT-FOOD ELEMENTS IN RAW MATERIALS AND CHEMICALS.

The trade values in the following schedule have been agreed upon by the Experiment Stations of Massachusetts, Rhode Island, Connecticut, New York, New Jersey and Vermont, as a result of study of the prices actually prevailing in the large markets of these states.

These trade values represent, as nearly as can be estimated, the average prices at which, during the six months preceding March,

* Below guarantee.

the respective ingredients, *in the form of unmixed raw materials,* could be bought at retail for cash in our large markets. These prices also correspond (except in case of available phosphoric acid) to the average wholesale prices for the six months preceding March plus about 20 per cent in case of goods for which there are wholesale quotations.

TRADE-VALUES OF PLANT-FOOD ELEMENTS IN RAW MATERIALS AND CHEMICALS.

	1898. Cts. per pound.
Nitrogen in ammonia salts	14
" in nitrates	13
Organic nitrogen in dry and fine-ground fish, meat and blood, and mixed fertilizers	14
" in cotton-seed meal and castor-pomace	12
" in fine ground bone and tankage	13½
" in coarse bone and tankage	10
Phosphoric acid, water-soluble	4½
" citrate-soluble	4
" in fine-ground fish, bone and tankage	4
" in coarse fish, bone and tankage	3½
" in cotton-seed meal, castor-pomace and wood ashes	4
" in mixed fertilizers, insoluble in ammonium citrate	2
Potash as high-grade sulphate, in forms free from muriates (chlorides), in ashes, etc	5
Potash in muriate	4¼

COMPARISON OF SELLING PRICE AND COMMERCIAL VALUATION.

Giving to the different constituents the values assigned in the schedule for mixed fertilizers, 14 cents a pound for nitrogen, 4 1-2 cents a pound for water-soluble phosphoric acid, 4 cents a pound for citrate soluble phosphoric acid, 2 cents a pound for insoluble phosphoric acid, and 4 1-4 cents a pound for potash, we can calculate the commercial valuation, or the price at which the separate unmixed materials contained in one ton of fertilizer, having the composition indicated in the preceding table, could be purchased for cash at retail at the seaboard. Knowing the retail prices at which these goods were offered for sale, we can also readily estimate the difference between the actual selling price or the mixed goods and the retail cash cost of the unmixed materials; the difference covers the cost of mixing, freight, profits, etc. We present these data in the following table, including only complete fertilizers.

COMMERCIAL VALUATION AND SELLING PRICE OF COMPLETE FERTILIZERS.

1898.	Commercial Valuation of Complete Fertilizers.	Selling Price of One Ton of Complete Fertilizer.			Average increase cost of mixed materials over unmixed materials.
	Average.	Lowest.	Highest.	Average.	
Spring	$18 52	$15 00	$45 00	$27 65	$9 13
Fall	17 34	14 25	35 00	23 16	5 82
Average for year	18 34	......	......	26 93	8 59

COMMERCIAL VALUATION AND SELLING PRICE OF CHEMICALS AND INCOMPLETE FERTILIZERS.

	Commercial Valuation.			Selling Price.			Average increase of selling price over commercial valuation.
	Lowest.	Highest.	Average.	Lowest.	Highest.	Average.	
Nitrate of soda	$38 48	$40 40	$39 44	$38 75	$40 00	$39 38	*$0 06
Sulphate of ammonia	......	......	56 95	......	......	60 00	3 05
Dissolved phosphate	10 25	26 65	13 10	11 00	26 00	15 53	2 43
Kainit	......	......	10 84	......	......	15 00	4 16
Muriate of potash	......	......	42 67	......	......	40 00	*2 67
Fish-scrap	18 05	30 14	25 67	14 00	26 00	21 67	*4 00
Bone-meal	11 94	30 41	25 32	20 00	38 00	27 70	2 38
Mixtures containing phosphoric acid and potash	8 93	18 38	13 06	15 00	30 00	20 00	6 94
Wood-ashes	3 03	8 37	5 77	9 00	12 00	10 30	4 53

* Commercial valuation greater than selling price.

COST OF ONE POUND OF PLANT-FOOD IN FERTILIZERS AS PURCHASED BY CONSUMERS.

In the table below we present figures showing the lowest, highest and average cost to the purchaser of one pound of plant-food in different forms.

COST OF ONE POUND OF PLANT-FOOD TO CONSUMERS.

	Lowest.	Highest.	Average
	Cents.	Cents.	Cents.
Nitrogen in			
Complete fertilizers	11.7	382.00	20.3
Bone-meal	10.6	26.7	14.7
Fish-scrap	10.9	12.	11.8
Nitrate of soda	12.9	13.1	13.
Sulphate of ammonia	.....	.....	14.7

COST OF ONE POUND OF PLANT-FOOD TO CONSUMERS.— *Concluded.*

	Lowest.	Highest.	Average.
	Cents.	Cents.	Cents.
Phosphoric acid in			
Complete fertilizers (available)	3.6	116.00	6.5
Dissolved phosphates (available)	3.8	10	5.3
Fish-scrap (total)	3.1	3.5	3.3
Bone-meal (total)	3	7.6	4.2
Phosphoric acid and potash mixtures (available)	5.3	12.6	6.9
Wood-ashes	4.3	13.9	7.2
Potash in			
Complete fertilizers	3.75	12.3	6.5
Kainit	.....	.....	5.9
Muriate of potash	.....	.....	4
Wood-ashes	5.4	17.4	9
Potash and phosphoric acid mixtures	5	11.9	6.9

TERMS USED IN STATING RESULTS OF ANALYSIS.

In the tables following, the terms used to express the results of analysis are self-explanatory for the most part. Attention is called, however, to "water-soluble" phosphoric acid and nitrogen.

While manufacturers are required to guarantee only the amount of available phosphoric acid (water-soluble plus reverted or citrate-soluble), yet it seems desirable that consumers should know what proportion of the available is water-soluble. The amounts of available phosphoric acid being equal, one would choose by preference a fertilizer containing the larger amount of water-soluble phosphoric acid.

The amount of water-soluble phosphoric acid varied from 0.62 to 9.78 per cent and averaged 5.72 per cent. This constituted nearly 62 per cent of the available phosphoric acid present.

The water-soluble nitrogen includes nitrogen present in the form of ammonia salts and nitrates together with that present in small amounts of soluble organic matter. The amount of water-soluble nitrogen varied from 0 to 3.02 per cent and averaged 0.54 per cent. This constituted 32.3 per cent of the total nitrogen present. It should not be inferred that water-soluble nitrogen is of more value than the rest. It is, of course, more readily available, so far as it consists of nitrates, but it must be remembered that nitrogen in this form leaches and is lost to plants more readily than nitrogen in other forms.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Baker & Engert, Lincoln, N. Y.	Alkaline bone.	Rochester.	5411
Baker & Engert, Lincoln, N. Y.	Giant king.	Rochester.	5406
Bowker Fertilizer Co., Boston, Mass.	A. Baldridge's Seneca Co. special.	Macdougall.	5290
Bowker Fertilizer Co., Boston, Mass.	A. Baldridge's Seneca queen.	Macdougall.	5292
Bowker Fertilizer Co., Boston, Mass.	Alkaline bone.	Newark.	5366
Bowker Fertilizer Co., Boston, Mass.	Brisbin & Douglass grain special.	Clyde.	5486
Bowker Fertilizer Co., Boston, Mass.	Brisbin & Douglass special wheat fertilizer.	Clyde.	5355
Bowker Fertilizer Co., Boston, Mass.	Chappius XXX phosphate.	Dryden.	5352
Bowker Fertilizer Co., Boston, Mass.	Dried blood.	Rochester.	5429
Bowker Fertilizer Co., Boston, Mass.	Hopkins' special fertilizer.	Canandaigua.	5398

LECTED IN NEW YORK STATE DURING THE FALL OF 1898.

IN 100 POUNDS OF FERTILIZER.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed Found	——	13 14.81	—— 14.81	4 4.03*	——	—— 2.71
Guaranteed Found	1.65 1.57	8 9.10	—— 10.86	4 4.22	—— 0.49	—— 4.24
Guaranteed Found	0.75 0.92	10 11.37	—— 15.15	4 4.85	—— 0.17	—— 8.81
Guaranteed Found	——	14 16.76	—— 17.28	——	——	—— 11.35
Guaranteed Found	——	11 13.80	—— 17.79	1 1.05	——	—— 10.34
Guaranteed Found	0.75 1.06	8 9.82	—— 11.17	4 3.80	—— 0.31	—— 6.55
Guaranteed Found	1.50 1.77	10 10.61	—— 13.77	5 4.95	—— 0.42	—— 6.07
Guaranteed Found	1 1.21	8 10.57	—— 12.50	1 1.43	—— 0.61	—— 7.01
Guaranteed Found	9.75 9.59	——	—— 4.80	——	—— 2.53	——
Guaranteed Found	1 1.18	10 10.51	—— 14.56	4 4.45	—— 0.39	—— 3.03

* Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Bowker Fertilizer Co., Boston, Mass.	Kinne's selected fertilizer.	Ovid.	5313
Bowker Fertilizer Co., Boston, Mass.	Muriate of potash.	Penfield.	5417
Bowker Fertilizer Co., Boston, Mass.	Onion special.	North Rose.	5487
Bowker Fertilizer Co., Boston, Mass.	Special grain.	Willow Creek.	5317
Bowker Fertilizer Co., Boston, Mass.	Wilson's golden sheaf.	Rochester.	5430
Bradley Fertilizer Co., Boston, Mass.	Grape fertilizer.	Rochester.	5409
Bradley Fertilizer Co., Boston, Mass.	Muriate of potash.	Newark.	5365
E. B. Chapin, Rochester, N. Y.	Standard.	Rochester.	5418
Cleveland Dryer Co., Cleveland, Ohio.	Forest City ammoniated superphosphate.	Cato.	5339

LECTED IN NEW YORK STATE DURING THE FALL OF 1898.

IN 100 POUNDS OF FERTILIZER.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	1	9	——	2.50	——	——
Found	1.27	10.77	13.42	2.89	0.25	6.59
Guaranteed	——	——	——	50	——	——
Found				52.36		
Guaranteed	0.75	6	——	5	——	——
Found	0.99	9.35	10.56	5.29	0.27	6.50
Guaranteed	0.75	8	——	4	——	——
Found	1.16	9.23	12.52	4.91	0.45	4.12
Guaranteed	0.75	10	——	6	——	——
Found	1.37	10.97	12.98	6.16	0.57	7.65
Guaranteed	0.82	4	——	8	——	——
Found	0.88	5.50	9.77	8.23	0.27	1.22
Guaranteed	——	——	——	50	——	——
Found				50.48		
Guaranteed	1.65	7	——	3	——	——
Found	1.34	6.45	8.42	5.87	0.33	2.50
Below guarantee	0.31	0.55				
Guaranteed	1.65	7	——	1	——	——
Found	1.83	8.93	10.89	1.22	0.40	6.68

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
E. Frank Coe Co., New York City.	Ralston's Knickerbocker phosphate.	Aurora.	5326
E. Frank Coe Co., New York City.	S. G. Lyon's ammoniated bone superphosphate.	Aurora.	5325
E. Frank Coe Co., New York City.	Wonder superphosphate.	Geneva.	5271
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Alkaline bone and potash.	Holley.	5480
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Buddington's corn and wheat grower.	Holley.	5479
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Cabbage, onion and celery manure.	Canandaigua.	5394
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Chappius special corn phosphate.	Dryden.	5354
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Chappius XXV phosphate.	Dryden.	5353
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Conklin's dissolved bone.	Penn Yan.	5385
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Crocker's phosphate.	Hilton.	5462

LECTED IN NEW YORK STATE DURING THE FALL OF 1898.

IN 100 POUNDS OF FERTILIZER.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed Found	1.75 1.83	8 9.76	—— 12.57	1.35 1.62	—— 0.83	—— 7.04
Guaranteed Found	1.20 1.34	8 10.69	—— 12.38	3 3.38*	—— 0.52	—— 8.25
Guaranteed Found	1 1.14	10 9.91	—— 12.84	3 4.17*	—— 0.51	—— 6.81
Guaranteed Found	——	8 8.25	—— 9.13	5 5.53	——	—— 5.26
Guaranteed Found	0.82 0.87	10 10.84	—— 12.03	5 5.12	—— 0.59	—— 7.42
Guaranteed Found	3.28 3.31	7 6.91	—— 8.53	7 7.62	—— 0.59	—— 3.87
Guaranteed Found	2 1.93	9 9.76	—— 10.64	2 2.44	—— 0.42	—— 6.30
Guaranteed Found	0.82 1.18	8 10.36	—— 10.95	2 2.82	—— 0.18	—— 7.27
Guaranteed Found	——	14 14.76	—— 16.57	——	——	—— 10.41
Guaranteed Found	1.23 1.10	10 11.98	—— 14.04	1.76 1.57	—— 0.08	—— 7.85

* Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Dissolved bone black.	Canandaigua.	5395
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	General phosphate.	Seneca.	5268
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Hanlon Bros. special.	Medina.	5470
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Harvest jewel.	Seneca.	5267
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	High-grade cereal guano.	Romulus.	5297
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Market garden special.	Seneca.	5269
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Potash salts.	Canandaigua.	5396
E. A. Cross, Hilton, N. Y	King superphosphate.	Hilton.	5460
E. A. Cross, Hilton, N. Y.	Parma superphosphate.	Hilton.	5461
E. A. Cross, Hilton, N. Y.	Queen superphosphate.	Hilton.	5459

LECTED IN NEW YORK STATE DURING THE FALL OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	——	16	——	——	——	——
Found		16.47	16.47			15.51
Guaranted	0.82	10	——	8	——	——
Found	1.31	10.53	11.60	7.38	0	7.15
Below guarantee				0.62		
Guaranteed	0.82	10	——	8.10	——	——
Found	1.29	9.94	11.57	8.46	0.13	7.28
Guaranteed	1.64	8	——	2	——	——
Found	1.95	7.80	10.37	2.17	0	4.97
Guaranteed	0.82	8	——	2	——	——
Found	1.10	8.32	10.15	2.11	0.10	4.55
Guaranteed	3.70	8	——	8	——	——
Found	3.95	8.13	8.76	8.43	1.19	6.20
Guaranteed	——	——	——	50	——	——
Found				51.28		
Guaranteed	2.35	8	——	3.40	——	——
Found	2.36	8.17	10.52	7.16		2.52
Guaranteed	1.65	8	——	3.20	——	——
Found	1.71	7.87	9.91	3.37	1.03	2.42
Guaranteed	2	8	——	3	——	——
Found	2.17	8.09	10.75	3.81	1.37	2.87

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Detrick Fertilizer & Chemical Co., Baltimore, Md.	Potash and bone.	Seneca Castle.	5275
Detrick Fertilizer & Chemical Co., Baltimore, Md.	Wheat mixture.	Seneca Castle.	5274
Louis F. Detrick, Baltimore, Md.	X. X. T. R. A. acid phosphate.	Groton.	5350
J. W. Dunbar, Attica, N. Y.	Grass and grain grower.	Attica.	5441
J. W. Dunbar, Attica, N. Y.	Special wheat fertilizer.	Attica.	5442
Farmers' Union Fertilizer Works, Buffalo, N. Y.	Dissolved bone and potash.	Eagle Harbor.	5472
Farmers' Union Fertilizer Works, Buffalo, N. Y.	Potato, tobacco, and truck manure.	Alexander.	5438
Farmers' Union Fertilizer Works, Buffalo, N. Y.	Standard phosphate.	Eagle Harbor.	5473
Louis Fechter, East Buffalo, N. Y.	East star fertilizer.	East Buffalo.	5450

LECTED IN NEW YORK STATE DURING THE FALL OF 1898.

IN 100 POUNDS OF FERTILIZER.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	———	10	———	6	———	———
Found		9.38	11.01	8.36		6.51
Below guarantee		0.62				
Guaranteed	1.65	8	———	4	———	———
Found	1.66	8.23	10.24	4.30	0.35	6.12
Guaranteed	———	14	———	———	———	———
Found		15.22	15.67			12.50
Guaranteed	1.82	8	———	4	———	———
Found	1.06	8.19	10.46	4.07	0.36	5.88
Guaranteed	1.65	8	———	5	———	———
Found	2.10	8.58	10.69	4.85	0.69	6.03
Guaranteed	———	8	———	2	———	———
Found		7.95	8.79	3.39		3.98
Guaranteed	1.85	9	———	4	———	———
Found	1.95	9.88	10.51	4.10	0.08	6.65
Guaranteed	1.23	9	———	2	———	———
Found	1.38	10.95	11.58	2.06	0.34	6.54
Guaranteed	5.38	4.15	———	1.31	———	———
Found	4.66	5.09	9.59	0.40	1.81	0
Below guarantee	0.72			0.91		

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Geneva Coal Co., Geneva, N. Y.	Harvest king.	Geneva.	5248
Geneva Coal Co., Geneva, N. Y.	New York standard wheat grower.	Geneva.	5247
Geneva Coal Co., Geneva, N. Y.	Reclaimer animal bone.	Geneva.	5249
Griffith & Boyd, Baltimore, Md.	A. Baldridge special N. Y. phosphate.	Macdougall.	5288
Griffith & Boyd, Baltimore, Md.	Farmers' potato manure.	Dryden.	5351
Griffith & Boyd, Baltimore, Md.	Fayette special bone and potash.	Macdougall.	5289
Griffith & Boyd, Baltimore, Md.	General crop complete fertilizer.	Kendaia.	5304
Griffith & Boyd, Baltimore, Md.	Original superphosphate.	Kendaia.	5302
Griffith & Boyd, Baltimore, Md.	Seneca County special.	Macdougall.	5294

LECTED IN NEW YORK STATE DURING THE FALL OF 1898.

	In 100 Pounds of Fertilizer.					
	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	0.82	9	—	2	—	—
Found	0.96	10.29	11.83	2.17	0.50	7.85
Guaranteed	1.65	9	—	2	—	—
Found	1.75	10.27	12.05	2.21	0.89	7.78
Guaranteed	1.85	9	—	4	—	—
Found	2.14	10.13	14.40	4.06	2.05	6.76
Guaranteed	0.82	8	—	2	—	—
Found	1.02	8.62	9.97	2.36	0.38	6.07
Guaranteed	0.85	8	—	9	—	—
Found	0.83	8.57	10.16	7.70	0.13	5.30
Below guarantee				1.30		
Guaranteed	—	12	—	5	—	—
Found		11.17	14.46	3.74		7.84
Below guarantee		0.83		1.26		
Guaranteed	0.82	8	—	4	—	—
Found	0.92	8.87	11.06	4.45*	0.32	5.67
Guaranteed	—	14	—	—	—	—
Found		15.10	16.59			10.47
Guaranteed	0.82	10	—	4	—	—
Found	1.06	9.43	11.12	3.64	0	5.89
Below guarantee		0.57		0.36		

* Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Griffith & Boyd, Baltimore, Md.	Seneca queen.	Macdougall.	5293
Griffith & Boyd, Baltimore, Md.	Thirteen and three.	Mapleton.	5337
Griffith & Boyd, Baltimore, Md.	XX potash manure.	Mapleton.	5336
Hanlon Bros., Medina, N. Y.	Complete manure.	Medina.	5380
Hanlon Bros., Medina, N. Y.	High-grade bone and potash.	Medina.	5379
Hanlon Bros., Medina, N. Y.	Special for potatoes and cabbage.	Medina.	5378
Hanlon Bros., Medina, N. Y.	Wheat, corn and oats.	Medina.	5381
J. S. Hewitt & Sons, Locke, N. Y.	Bone and potash superphosphate.	Locke.	5347
J. S. Hewitt & Sons, Locke, N. Y.	Cayuga County pride.	Locke.	5348

LECTED IN NEW YORK STATE DURING THE FALL OF 1898.

IN 100 POUNDS OF FERTILIZER.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	——	14	——	——	——	——
Found		13.85	15.67			10.25
Guaranteed	——	13	——	3	——	——
Found		11.59	13.72	4.38		7.94
Below guarantee		1.41				
Guaranteed	——	10	——	5	——	——
Found		9.80	11.96	5.63		6.65
Guaranteed	0.82	8	——	4	——	——
Found	1.87	10.02	12.04	2.19	0.84	2.92
Below guarantee				1.81		
Guaranteed	——	13	——	3	——	——
Found		13.93	14.32	3.03		9.83
Guaranteed	3.29	7	——	8	——	——
Found	3.53	7.29	8.87	8.10	1.94	4.36
Guaranteed	1.85	9	——	4	——	——
Found	1.94	9.75	11.03	4.44	0.57	7.29
Guaranteed	——	10	——	2	——	——
Found		10.07	11.63	2.60		6.91
Guaranteed	2.06	8	——	4	——	——
Found	1.73	8.19	10.47	4.09	0.10	5.63
Below guarantee	0.33					

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
J. S. Hewitt & Sons, Locke, N. Y.	Special grain and grass.	Locke.	5346
C. C. Hicks, Penn Yan, N. Y.	Ontario wheat special.	Seneca Castle.	5278
Humphrey & Holdridge, Honeoye Falls, N. Y.	Best grain.	Honeoye Falls.	5282 5283
Humphrey & Holdridge, Honeoye Falls, N. Y.	Dissolved bone.	Honeoye Falls.	5284
Humphrey & Holdridge, Honeoye Falls, N. Y.	Standard phosphate.	Honeoye Falls.	5281
Lazaretto Guano Co., Baltimore, Md.	Pure ground bone.	Attica.	5447
Liebig Manufacturing Co., Carteret, N. J.	Special mixture.	Moravia.	5342
Liebig Manufacturing Co., Carteret, N. J.	Van Duyne & O'Hara's high-grade bone and potash.	Moravia.	5344

LECTED IN NEW YORK STATE DURING THE FALL OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	0.82	8	——	4	——	——
Found	0.97	8.29	10.37	3.94	0.11	7.33
Guaranteed	1.64	10	——	5	——	——
Found	1.47	11.11	12.93	4.04	0.13	8.11
Below guarantee				0.96		
Guaranteed	1.23	10	——	6	——	——
Found	1.70	10.41	12.48	5.79	0.80	8.02
Below guarantee				0.21		
Guaranteed	——	14	——	——	——	——
Found		13.80	15.25			5.53
Guaranteed	1.23	10	——	3	——	——
Found	1.30	12.30	13.70	2.87	0.05	9.78
Guaranteed	3.70	——	20	——	——	——
Found	4.61		18.70		0.31	
Below guarantee			1.30			
Guaranteed	4.10	8	——	7	——	——
Found	4.69	9.42	9.84	7.82*	3.02	7.50
Guaranteed	——	10	——	5	——	——
Found		10.88	13.62	4.85		6.43

* Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Liebig Manufacturing Co., Carteret, N. J.	Van Duyne & O'Hara's standard phosphate.	Moravia.	5343
Liebig Manufacturing Co., Carteret, N. J.	Van Duyne & O'Hara's T. & F. bone.	Moravia.	5345
Lister's Agr'l Chemical Works, Newark, N. J.	Crop grower.	Lodi.	5316
Lister's Agr'l Chemical Works, Newark, N. J.	Minot & Decker's ammoniated dissolved bone and potash.	Newark.	5485
Fred'k Ludlam, New York City.	Sickle brand.	Magee.	5252
Maryland Fertilizer Co., Baltimore, Md.	Ammoniated fertilizer O. K.	Holley.	5482
Maryland Fertilizer Co., Baltimore, Md.	Bone superphosphate.	Magee. Holley.	5257 5481
Maryland Fertilizer Co., Baltimore, Md.	Tornado fertilizer.	Fairport.	5362
Miller Fertilizer Co., Baltimore, Md.	Harvest queen.	Kendall.	5357

LECTED IN NEW YORK STATE DURING THE FALL OF 1898.

	In 100 Pounds of Fertilizer.					
	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	1.25	10	—	2.50	—	—
Found	1.25	10.10	11.94	1.45	0.43	0.62
Below guarantee				1.05		
Guaranteed	—	13	—	5	—	—
Found		13.99	14.39	4.88		9.17
Guaranteed	0.83	8	—	1	—	—
Found	1.06	8.39	9.21	1.51	0	4.10
Guaranteed	0.82	8	—	4	—	—
Found	0.95	8.37	10.21	4*	0.13	4.43
Guaranteed	—	10	—	1	—	—
Found		9.88	13.10	1.20		3.69
Guaranteed	0.82	8	—	2	—	—
Found	1.06	8.87	11.58	2.64	0.35	4.58
Guaranteed	—	10	—	2	—	—
Found		11.45	12.15	2.55		8.89
Guaranteed	0.41	11	—	3.25	—	—
Found	0.46	13.45	14.36	2.86	0.25	9.44
Below guarantee				0.39		
Guaranteed	1	10	—	2.25	—	—
Found	1.57	9.97	11.34	2.35	0.28	6.58

* Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand	Locality where sample was taken.	Station number.
Miller Fertilizer Co., Baltimore, Md.	Hustler phosphate.	Stanley. Kendall.	5264 5358
Miller Fertilizer Co., Baltimore, Md.	Special cabbage.	Stanley.	5263
Miller Fertilizer Co., Baltimore, Md.	Special wheat grower.	Kendall.	5356
Milsom Rendering & Fertilizer Co., Buffalo, N. Y.	Acidulated bone and potash.	Penn Yan.	5383
Milsom Rendering & Fertilizer Co., Buffalo, N. Y.	Attica special.	Attica.	5440
Milsom Rendering & Fertilizer Co., Buffalo, N. Y.	Ballsmith & Moritz's special.	Attica.	5439
Milsom Rendering & Fertilizer Co., Buffalo, N. Y.	Dried blood.	Canandaigua.	5400
Milsom Rendering & Fertilizer Co., Buffalo, N. Y.	Fourteen per cent. acid phosphate.	Penn Yan.	5382
Milsom Rendering & Fertilizer Co., Buffalo, N. Y.	General crop No. 2.	Kendaia.	5303

LECTED IN NEW YORK STATE DURING THE FALL OF 1898.

IN 100 POUNDS OF FERTILIZER.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	0.82	9	——	2.25	——	——
Found	0.91	9.40	10.75	3.32	0.14	6.62
Guaranteed	3.30	7	——	7	——	——
Found	3.47	7.36	9.09	7.32	0.20	5.23
Guaranteed	1.65	8	——	2	——	——
Found	1.59	8.51	11.41	2.47	0.16	5.86
Guaranteed	——	10	——	8	——	——
Found		10.59	10.99	8.22		7.09
Guaranteed	0.85	8	——	4	——	——
Found	1.04	7.91	10.49	4.44	0.54	5.71
Guaranteed	1.85	8	——	4	——	——
Found	1.81	8.51	9.98	3.18	0.67	6.20
Below guarantee				0.82		
Guaranteed	10.52	——	——	——	——	——
Found	9.27				1.25	
Below guarantee	1.27					
Guaranteed	——	14	——	——	——	——
Found		16.64	16.98			13.01
Guaranteed	0.82	9	——	7	——	——
Found	1.02	9.28	11.18	5.99	0.52	7.38
Below guarantee				1.01		

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER	Trade name or brand.	Locality where sample was taken.	Station number.
Milsom Rendering & Fertilizer Co., Buffalo, N. Y.	Morgan & Linson's high-grade.	Albion.	5478
Milsom Rendering & Fertilizer Co., Buffalo, N. Y.	Tankage.	Canandaigua.	5399
Minot & Decker, Brockport, N. Y.	Soluble bone.	Brockport.	5359
Oakfield Fertilizer Co., Buffalo, N. Y.	Great value fertilizer.	Oakfield.	5458
Oakfield Fertilizer Co., Buffalo, N. Y.	Potato and tobacco fertilizer.	Oakfield.	5457
Oakfield Fertilizer Co., Buffalo, N. Y.	Special corn and wheat manure.	Oakfield.	5453
Oakfield Fertilizer Co., Buffalo, N. Y.	Standard fertilizer.	Oakfield.	5454
Pacific Guano Co., Boston, Mass.	Alkaline bone.	Fairport.	5361

LECTED IN NEW YORK STATE DURING THE FALL OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	1.64	8	——	4	——	——
Found	1.54	6.70	9.37	3.32	0.66	4.08
Below guarantee		1.30		0.68		
Guaranteed	6.15	——	——	——	——	——
Found	7.16	7.90	12.27		1.30	
Guaranteed	——	14	——	——	——	——
Found		16.86	17.08			11.81
Guaranteed	0.82	6	——	1.08	——	——
Found	0.83	6.43	6.78	1.18	0.01	3.30
Guaranteed	2.47	6	——	4.32	——	——
Found	2.28	4.77	7.29	3.81*	0.06	2.60
Below guarantee		1.23		0.51		
Guaranteed	3.70	8	——	6	——	——
Found	2.93	6.39	8.95	5.51	0.73	3.73
Below guarantee	0.77	1.61		0.49		
Guaranteed	2.47	10	——	1.62	——	——
Found	2.09	8.40	10.63	1.57	0.43	5.51
Below guarantee	0.38	1.60				
Guaranteed	——	10	——	4	——	——
Found		11.15	13.30	3.83		4.83

* Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand	Locality where sample was taken.	Station number.
Patapsco Guano Co., Baltimore, Md.	Alkaline soluble bone.	Albion.	5476
Patapsco Guano Co., Baltimore, Md.	Soluble bone and potash.	Albion.	5477
G. A. Pearsall, Williamson, N. Y.	Bean special.	Williamson.	5370
G. A. Pearsall, Williamson, N. Y.	Dissolved phosphate.	Williamson.	5371
G. A. Pearsall, Williamson, N. Y.	Potato and onion fertilizer.	Williamson.	5369
A. Peterson, Penfield, N. Y.	High-grade potato phosphate.	Penfield.	5414
A. Peterson, Penfield, N. Y.	Farmers' benefit.	Penfield.	5416
A. Peterson, Penfield, N. Y.	Penfield standard.	Penfield.	5415
W. W. Phipps, Albion, N. Y.	Ammoniated dissolved bone with potash.	Eagle Harbor.	5474
W. W. Phipps, Albion, N. Y.	Eagle brand superphosphate and potash.	Eagle Harbor.	5471

LECTED IN NEW YORK STATE DURING THE FALL OF 1898.

IN 100 POUNDS OF FERTILIZER.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	——	13	——	3	——	——
Found		14.22	14.46	3.17		10.91
Guaranteed	——	10	——	2	——	——
Found		11.77	13.61	2		8.58
Guaranteed	0.82	8	——	4	——	——
Found	1.30	8.22	11.09	4.21	0.24	5
Guaranteed	——	14	——	——	——	——
Found		14.11	15			9.82
Guaranteed	4.10	8	——	5	——	——
Found	3.13	10.38	10.99	4.43	1.18	7.37
Below guarantee	0.97			0.57		
Guaranteed	2.50	6.50	——	9	——	——
Found	3.17	8.48	11.55	10.43	1.72	3.40
Guaranteed	1.25	6	——	2	——	——
Found	2.54	10.62	14.12	2.19	1.20	4.45
Guaranteed	2.25	8	——	4	——	——
Found	3.13	10.28	13.60	5.70	1.82	4.19
Guaranteed	1.64	11	——	2	——	——
Found	1.78	13.05	15.33	4.45	0.	8.82
Guaranteed	——	13	——	2	——	——
Found		12.98	15.85	2.49		7.79

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
H. A. Pierce & Co., Armor, N. Y.	Bone and meat.	Armor.	5449
H. A. Pierce & Co., Armor, N. Y.	Pure bone.	Armor.	5448
Potomac Fertilizer Co., Boston, Mass.	Bone and potash.	Fleming.	5341
Potomac Fertilizer Co., Boston, Mass.	Special fertilizer.	Fleming.	5340
Queen City Fertilizer Co., Buffalo, N. Y.	Ammoniated bone.	Lockport.	5468
Queen City Fertilizer Co., Buffalo, N. Y.	Wheat, corn and seeding-down.	Lockport.	5467
Quinnipiac Co., New York City.	Anscomb's special wheat.	Rochester.	5407
Quinnipiac Co., New York City.	Bachman's special complete manure.	Macdougall.	5295
Quinnipiac Co., New York City.	Bone meal.	Rochester.	5413
Quinnipiac Co., New York City.	Grain and seeding.	Oakwood.	5323

LECTED IN NEW YORK STATE DURING THE FALL OF 1898.

	In 100 Pounds of Fertilizer.					
	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	6.04	——	8.25	0.48	——	——
Found	6.59		11.03	0.36	1.90	
Guaranteed	2.51	——	24.55	——	——	——
Found	2.88		26.75		0.70	
Guaranteed	——	10	——	6	——	——
Found		11.88	12.59	3.67		7.08
Below guarantee				2.33		
Guaranteed	1.65	8	——	4	——	——
Found	1.63	9.47	11.29	4.12	0.49	6
Guaranteed	0.82	9	——	2	——	——
Found	0.94	9.11	10.78	3.59	0.50	6.20
Guaranteed	0.82	8	——	4	——	——
Found	0.95	8.68	10.18	4.15	0.48	5.93
Guaranteed	0.82	10	——	8	——	——
Found	0.72	11.81	12.91	8.22*	0.63	5.53
Guaranteed	0.82	10	——	4	——	——
Found	1.12	10.82	12.87	3.94	0.33	7.52
Guaranteed	2.45	——	20	——	——	——
Found	3.32		22.79		0.33	
Guaranteed	0.82	8	——	5	——	——
Found	0.92	10.45	12.68	4.82	0.14	7.33

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Quinnipiac Co., New York City.	Potash and bone.	Oakwood.	5324
Read Fertilizer Co., New York City.	Corn, wheat and rye.	Webster.	5376
Read Fertilizer Co., New York City.	Dried blood.	Phelps.	5386
Read Fertilizer Co., New York City.	Muriate of potash.	Phelps.	5387
Read Fertilizer Co., New York City.	Nitrate of soda.	Phelps.	5388
Read Fertilizer Co., New York City.	Seneca special.	Romulus.	5314
Rochester Fertilizer Works, Rochester, N. Y.	Blood and bone guano XX.	Rochester.	5419
Rochester Fertilizer Works, Rochester, N. Y.	Perfection brand.	Rochester.	5420
Rochester Fertilizer Works, Rochester, N. Y.	Potato manure.	Rochester.	5423

LECTED IN NEW YORK STATE DURING THE FALL OF 1898.

	In 100 Pounds of Fertilizer.					
	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	——	10	——	6	——	——
Found		11	14.35	5.95		3.57
Guaranteed	1.65	8	——	4	——	——
Found	1.90	9.58	10.09	4.34	0.19	6.39
Guaranteed	10	——	——	——	——	——
Found	10.55				0.71	
Guaranteed	——	——	——	50	——	——
Found				53.20		
Guaranteed	16	——	——	——	——	——
Found	15.76				15.76	
Below guarantee	0.24					
Guaranteed	1.23	9	——	2	——	——
Found	1.54	10.98	11.68	2.28	0.28	7.08
Guaranteed	0.82	8	——	4	0.28	——
Found	0.97	8.96	9.87	4.28*	0.49	5.60
Guaranteed	2.46	8	——	3	——	——
Found	2.96	9.89	11.08	3.75*	1.80	7.10
Guaranteed	2.87	8	——	5.40	——	——
Found	3.10	10.28	11.86	4.48*	1.64	7.55
Below guarantee				0.92		

* Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Rochester Fertilizer Works, Rochester, N. Y.	Tankage.	Rochester.	5424
Sessions & Leonard, Palmyra, N. Y.	Guano ammoniated bone.	Palmyra.	5377
Sessions & Leonard, Palmyra, N. Y.	Wayne County special.	Palmyra.	5364
Sheldon & Co., Buffalo, N. Y.	Pure ground bone.	Brockport.	5360
Spaulding & Conde, Lyndonville.	High-grade fertilizer.	Lyndonville.	5463
Standard Fertilizer Co., Boston, Mass.	Empire State.	Rochester.	5408
Standard Fertilizer Co., Boston, Mass.	Hop special.	Rochester.	5410
F. W. Tassell, Williamson, N. Y.	Wheat special.	Williamson.	5372
F. W. Tassell, Williamson, N. Y.	Williamson standard.	Williamson.	5373

LECTED IN NEW YORK STATE DURING THE FALL OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	7.40	———	———	———	———	———
Found	7.81		7.37		4.62	
Guaranteed	0.82	8	———	4	———	———
Found	1.21	8.66	11.87	5.53	0.22	3.92
Guaranteed	1.85	9	———	4	———	———
Found	1.70	9.95	11.40	4.48	0.49	7.74
Guaranteed	2.70	10	22	———	———	———
Found	3.35	7.36	21.45		0.70	
Below guarantee		2.64	0.55			
Guaranteed	0.75	5	———	8.50	———	———
Found	1.16	6.56	8.75	9.56	0.20	4.47
Guaranteed	0.82	4	———	8	———	———
Found	2	7.27	8.89	7.84	0.69	3.55
Guaranteed	1.65	8	———	4.30	———	———
Found	1.46	8.32	10.98	5.38*	0.30	3.34
Guaranteed	1.50	10	———	3	———	———
Found	1.89	9.97	12.91	3.46	1.25	6.25
Guaranteed	1	8	———	3.25	———	———
Found	0.84	10.32	12.73	5.57	0.06	5.53

* Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
I. P. Thomas, Philadelphia, Pa.	S. C. phosphate.	Penn Yan.	5384
E. D. Tolles, Attica, N. Y.	Animal bone.	Attica.	5446
E. D. Tolles, Attica, N. Y.	Barnyard manure.	Attica.	5445
E. D. Tolles, Attica, N. Y.	Tolles' guano.	Attica.	5444
Henry F. Tucker Co., Boston, Mass.	Special potato fertilizer.	Brighton.	5403
G. O. P. Turner, Churchville, N. Y.	Grain special.	Churchville.	5434
G. O. P. Turner, Churchville, N. Y.	High-grade guano.	Churchville.	5433
G. O. P. Turner, Churchville, N. Y.	None such fertilizer.	Churchville.	5432
Walker Fertilizer Co., Clifton Springs, N. Y.	Acid phosphate.	Phelps Junction.	5392

LECTED IN NEW YORK STATE DURING THE FALL OF 1898.

IN 100 POUNDS OF FERTILIZER.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	———	14	———	———	———	———
Found		14.39	18.61			3.73
Guaranteed	1.85	8	———	4	———	———
Found	2.29	10.45	14.22	4.01	1.38	6.60
Guaranteed	0.82	8	———	4	———	———
Found	0.97	9.16	10.48	4.20	0.46	5.97
Guaranteed	1.85	9	———	4	———	———
Found	1.87	10.33	11.29	4.09	0.49	7.74
Guaranteed	2.06	8	———	4	———	———
Found	2.57	9.89	10.83	4.09	0.25	5.53
Guaranteed	1.65	8	———	3	———	———
Found	1.83	8.18	10.76	3.22	0.92	6.28
Guaranteed	2.50	9	———	4.75	———	———
Found	2.12	10.07	11.48	6.39	0.79	5.11
Below guarantee	0.38					
Guaranteed	1.25	10	———	7	———	———
Found	1.79	10.67	12.13	4.71	0.72	5.75
Below guarantee				2.29		
Guaranteed	———	14	———	———	———	———
Found		14.10	14.44			9.31

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Walker Fertilizer Co., Clifton Springs, N. Y.	Ammoniated phosphate.	Phelps Junction.	5390
Walker Fertilizer Co., Clifton Springs, N. Y.	Ontario brand.	Phelps Junction.	5389
Walker Fertilizer Co., Clifton Springs, N. Y.	Special mixture.	Phelps Junction.	5391
Walker Fertilizer Co., Clifton Springs, N. Y.	Victoria bone.	Albion.	5475
Walker Fertilizer Co., Clifton Springs, N. Y.	Wheat special No. 1.	Phelps Junction.	5393
Williams & Clark Fertilizer Co., New York City.	Goodrich grain fertilizer.	Lima.	5287
Williams & Clark Fertilizer Co., New York City.	Kainit.	Rochester.	5412
Williams & Clark Fertilizer Co., New York City.	Royal grain phosphate.	Middleport.	5469
Williams & Clark Fertilizer Co., New York City.	Standard grain fertilizer.	Holley.	5484

LECTED IN NEW YORK STATE DURING THE FALL OF 1898.

	In 100 Pounds of Fertilizer.					
	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	1.65	8	——	1	——	——
Found	1.25	9.16	9.41	0.77	0.11	4.06
Below guarantee	0.40			0.23		
Guaranteed	——	10	——	4	——	——
Found		10.58	1.09	3.46		5.75
Below guarantee				0.54		
Guaranteed	0.82	10	——	5	——	——
Found	0.79	9.95	13.19	5.87	0.16	4.41
Guaranteed	0.82	8	——	1.50	——	——
Found	0.95	8.19	10.18	1.85	0	4.55
Guaranteed	0.82	8	——	5	——	——
Found	0.62	8.36	8.57	4.12	0.12	4.89
Below guarantee				0.88		
Guaranteed	2	10	——	5	——	——
Found	2.20	9.84	12.49	4.92	0.22	7.27
Guaranteed	——	——	——	12.48	——	——
Found				14.20		
Guaranteed	0.82	8	——	4	——	——
Found	1.06	7.87	11.09	3.90	0.23	3.16
Guaranteed	1.03	8	——	4	——	——
Found	1.34	8.06	11.38	4.33	0.68	3.53

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL

MANUFACTURER.	Trade name or brand	Locality where sample was taken.	Station number.
Williams & Clark Fertilizer Co., New York City.	Standard grain and vegetable fertilizer.	Holley.	5483
Wooster & Mott, Union Hill, N. Y.	Alkaline bone.	Union Hill.	5374
Wooster & Mott, Union Hill, N. Y.	Special manure for potatoes and onions.	Union Hill.	5375
Zell Guano Co., Baltimore, Md.	Hoster's high-grade wheat fertilizer.	Canoga.	5308
Zell Guano Co., Baltimore, Md.	Potato and cabbage special.	Lyons.	5368
Zell Guano Co., Baltimore, Md.	Special grain.	Romulus.	5315

LECTED IN NEW YORK STATE DURING THE FALL OF 1898.

In 100 Pounds of Fertilizer.

	Pounds of nitrogen.	Pounds of available phosphoric acid.	Pounds of total phosphoric acid.	Pounds of water-soluble potash.	Pounds of water-soluble nitrogen.	Pounds of water-soluble phosphoric acid.
Guaranteed	1.64	8	——	4	——	——
Found	2.08	7.33	11.25	4.34	0.53	1.95
Below guarantee		0.67				
Guaranteed	——	13	——	3	——	——
Found		13.46	13.95	3.03		10.11
Guaranteed	2.46	7	——	7	——	——
Found	2.44	8.65	10.24	8.18	0.78	6.27
Guaranteed	1.65	10	——	5	——	——
Found	1.58	12.01	13.08	5.02	0.12	9.03
Guaranteed	2.45	7	——	8	——	——
Found	2.44	9.37	10.44	7.82	0.23	7.37
Guaranteed	0.80	8	——	4	——	——
Found	1	10.68	11.72	4.07	0.12	8.01

REPORT

OF THE

DEPARTMENT OF ENTOMOLOGY.

Entomologists.

VICTOR H. LOWE, B. S.

F. A. SIRRINE, M. S.*

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* At the Branch Station in Second Judicial Department.

REPORT OF THE ENTOMOLOGISTS.

PART I.

I. THE COTTONWOOD LEAF BEETLE.*

Lina scripta Fab.

V. H. Lowe.

SUMMARY.

During the past four years the growers of basket willows in central New York have suffered serious loss from the depredations of the cottonwood leaf beetle.

In both the larval and the mature stages, the insect attacks the willows, feeding upon the young leaves and tender bark near the tips. This injury to the tips causes the willow "whips" to branch, thus rendering them worthless for basket making purposes.

It lives above ground during all of its transformations. The eggs are laid upon the leaves and the larvæ feed upon the more tender tissues. The pupæ are attached to the under sides of the leaves or to the bark. The mature insects, beetles, are active and fly readily from one field to another. The winter is passed in the adult stage, the beetles seeking shelter under stones, logs or any convenient rubbish.

On the experimental field the willows were successfully protected by three applications of green arsenite, 1 pound to 100 gallons of water.

*Reprint from Bulletin No. 143.

INTRODUCTION.

The industry of growing basket willows in central New York has been seriously handicapped by an insect known among willow growers as the "willow beetle," but among writers on economic entomology as the cottonwood leaf beetle. It is a species which, previous to 1894, attracted but little attention in the east, although it has long been known as a serious pest to cottonwood in the middle and western states. Since the winter of 1893-94 this insect has been very abundant in this State, especially in Onondaga County, doing great damage in the willow fields about Syracuse and Liverpool.

The investigations and experiments reported in this Bulletin were undertaken at the urgent request of some of the leading willow growers of the State. The life history and habits of the insect were studied only during the several visits made to the infested fields, as no suitable place for breeding the beetles at or near the Station was available. The experiments cover a period of two years, and were undertaken with a view to determining, if possible, a satisfactory method of protecting the willows from serious injury by this insect.

GENERAL NOTES UPON THE BEETLE.

CLASSIFICATION AND NAME.

This species is classified with the large and economically important group of beetles scientifically known as the *Chrysomelidae*. This group includes the leaf-eating beetles and among them are found some of the most pernicious of the insect pests.

Probably because this insect first attracted most attention as an enemy to the cottonwood, it was given the name of "Cottonwood Leaf Beetle" or the "Streaked Cottonwood Leaf Beetle." In this State, however, it is little known excepting as a pest to basket willows and hence is known among willow growers as the "Willow Beetle" or incorrectly "The Willow Bug." The scientific name, "*Lina scripta*"[1] was given the species by Fabricius.

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[1] Identified by Mr. E. A. Schwarz.

ECONOMIC IMPORTANCE.

Fortunately this insect does not have a wide range of food plants or it would doubtless have become of much more economic importance than it is. Where cottonwoods, poplars or willows are extensively grown, however, it may become a very serious pest. In the Dakotas, Nebraska, Kansas and Missouri, the insects appear in great numbers, stripping the leaves from large areas of these trees, thus causing serious injury throughout the districts where trees of this kind are valued for timber.

In this State the insect is a serious pest to one of the small, but important industries. Probably the greatest injury was during 1894 and 1895. In Onondaga County, where basket willows are extensively grown, from half to three-fourths of the crop was rendered worthless. In the vicinity of Liverpool alone, the crop was estimated to be about 1,200 tons less in 1895 than in 1894, the shortage being caused by the beetles. As a further example one farmer near Liverpool who grows 20 acres of willows, which yield under ordinary circumstances about five tons per acre, bringing from $16.00 to $40.00 per ton, harvested in 1894 only about $200 worth of marketable willows, and the following year his returns were but little better. This is but one of many cases of the kind that might be mentioned to show the serious injury which this insect is capable of doing. Fortunately the beetles were somewhat less abundant during 1896 and 1897.

IMPORTANCE AS A PEST TO NURSERY STOCK.

As a rule the cottonwood leaf beetle does but little injury in the nursery, especially in the east. There have been a few instances, however, where the beetles have appeared in eastern nurseries in sufficient numbers to do serious injury. One of the most important of these is recorded in *Insect Life*[2] by Mr. Thos. B. Meehan, who

[2] 1: 51.

states that the "willow beetle" did serious injury in his nursery at Germantown, during the spring of 1887, to Carolina poplars and Kilmarnock and New American willows.

In this State, the only instance of injury to nursery stock by this insect, which has come under the writer's notice, was in the nurseries of the Smiths & Powell Co. of Syracuse. In 1895 and 1896 the beetles did serious injury in a few blocks of Carolina and Norway poplars. They were especially injurious during the spring of 1896, threatening to ruin all of the Norway and Carolina poplars in this nursery.

HISTORY AND PRESENT DISTRIBUTION.

The original home of the cottonwood leaf beetle is not positively known.

In this country, it did not attract much attention until about 1876. In 1877 and 1878 the beetles did serious injury to cottonwood in the prairie states, especially Dakota, Kansas and Nebraska, where the cottonwood is valued for both ornamental and commercial purposes. In 1884 the cottonwoods in these sections were again seriously injured by the beetles which, it is said, appeared in swarms, quickly stripping the trees of their leaves.

On the authority of Dr. C. V. Riley[3] the habit of feeding on cottonwood was acquired long after the species was known as a pest to willows, and he suggests that "a special cottonwood feeding race of the species has of late years been developed."

The cottonwood leaf beetle occurs throughout the United States, and, according to Mr. E. A. Schwarz, in a recent letter to the writer, is found as far south as the City of Mexico. It is best known as an injurious species along the Mississippi Valley.

In this State it is little known outside the willow-growing districts. It first attracted the attention of the willow growers in

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[3] U. S. Dept. Agr. Ann. Rpt. 1884: 337; reprint from article in N. Y. Tribune, Oct. 9, 1878.

1875, when more than 50 acres of willows in Onondaga County were practically destroyed. From that time until 1893 the beetles did not appear in sufficient numbers to do serious injury. In the spring of 1894 the beetles appeared in swarms throughout the willow growing sections of the central part of the State, greatly reducing the yield of marketable willows. During 1895 and 1896 there was no apparent decrease in the number of beetles and the injury to the willows was not lessened. In 1897 the beetles were somewhat less numerous, but still sufficiently abundant to do great injury to the willows.

Although widely distributed throughout the State, the distribution of the species as a seriously injurious pest is practically limited by Oneida, Madison, Onondaga and Cayuga Counties. Although basket willows are grown commercially in at least eight counties west of Cayuga, the beetles have not been found in sufficient numbers to do serious injury.

FOOD PLANTS.

The principal food plants of this species are willow and cottonwood. It has also been found upon the box-elder.

HOW THE WILLOWS ARE INJURED.

The nature of the injury caused by the beetles will doubtless be better understood after a brief explanation of the method of growing basket willows. The principal species cultivated is the European osier, *Salix viminalis*. As previously stated by Dr. Lintner[4] the willows are propagated by cuttings. These cuttings are nine inches in length and are set six inches into the ground, and about fourteen or fifteen inches apart in rows about three feet apart. The young willows grow rapidly, a good growth averaging from five to six and one-half feet in a season. They are large enough to cut the second year, but produce only about

[4] New York State Entomologist Rept., 1895: 185.

two tons per acre, and may continue to yield good crops for from ten to fifteen years. By November the willow whips are ready to cut, the old stubs being left to produce the next year's crop.

It is the object of the grower to produce a tall, straight but flexible growth about one-eighth of an inch in diameter at base and measuring from five to nine feet in height. The injury caused by the beetles is not so much the weakening of the plant by loss of foliage as by the branching of the willow whips which results from the injury to the rapidly growing tips. The beetles which have lived over winter are astir early in May and feed for two or three weeks. They attack the young willows vigorously, feeding largely on the new growth, thus causing the tips to wilt and die. Frequently the entire tip is eaten off. In this manner irreparable injury is caused at the beginning of the season. Plate XVIII is from a photograph showing a bunch of young willows with injured tips. Plate XIX is from a photograph of a normal willow whip, and one which was injured early in the season in a manner similar to those shown at Plate XVIII. At *a* the willow was eaten off or sufficiently to stop the growth, thus resulting in the sprouts and consequent worthless willows, as these sprouts never become long enough for basket-making purposes. The uninjured willow is shown on the left.

The injurious work begun by the beetles is continued by the larvæ and adults of the next brood, and as these are much more numerous and appear at a time when the willows are growing at their best, the injury is much greater.

DESCRIPTIVE DETAILS.

DESCRIPTIONS AND LIFE HISTORY.

Appearance in the spring.— The beetles which have lived over winter come forth from their retreats during the latter part of April or early in May. In the vicinity of Syracuse they are usually first seen from the 1st to the 10th of May. As pre-

PLATE XVIII.

viously stated the beetles feed voraciously on the new growth, preferring the tender bark, but also feeding upon the leaves, and frequently devouring the young shoots before they have fairly started.

The egg.— Egg-laying begins about the 10th to the 15th of May and may continue for a week or more. The eggs are deposited in groups, usually on the under surface of the willow leaves, but they were frequently found upon blades of grass or leaves of weeds growing in the willow rows. Each egg is firmly fastened on end to the leaf and usually in a slightly slanting position as shown at Plate XX, on the left of Figure 1. These groups vary in the number of eggs contained. In about 15 examined the number varied from 25 to 52. The average number is about 45.

The eggs are light lemon-yellow in color, turning to a deep salmon just before hatching. They are elongate-oval in outline and vary in size from 1.35 mm. by 0.63 mm. to 1.47 mm. by 0.84 mm. The shell is smooth, thick and leathery.

Period of incubation.— The period of incubation is usually from 10 days to 2 weeks. This was the period for 1894, 1895 and 1896. Last spring was an exception, as few of the eggs hatched within 20 days.

The larva.— When first hatched the larvæ measure from 1.05 mm. to 1.11 mm. in length. The diameter of the head is 0.6 mm. and that of the body 0.54 mm. on the anterior half, tapering to 0.21 mm. at the last abdominal segment. The entire body is black or very dark brown. When full grown they measure, on an average, about 8 mm. in length. The width of the head is 0.75 mm. and of the body, on the anterior half, 2.5 mm. tapering to about 0.6 mm. on the last abdominal segment. The body is of a dirty yellowish color, the head a dark brown and the legs black. A double row of dark brown spots, two on each segment, extends along the upper surface of the abdomen. In a line with these is a row of black tubercles on each side which, when the insect is disturbed, emit drops of white milky fluid, of a strong pungent odor, which may be drawn back when the threatened danger is

past. Two tubercles, nearly white with dark colored tips, are conspicuous on the lateral margins of the first two abdominal segments. At the tip of the abdomen is a disc covered with a sticky substance which is used both as an aid in crawling about and to hold to the support when necessary. This is especially true with the newly-hatched larvæ. Its chief office, however, appears to be as a means of attaching the larvæ to the leaf when about to pupate and to hold the suspended pupa until the beetle emerges. The larvæ are mature in about two weeks.

Habits of the larva.— The newly-hatched larvæ remain for a few hours crawling about over the empty egg shells, but soon settle down in the immediate vicinity and begin gnawing through the epidermis to feed on the soft tissues beneath. They feed side by side for three or four days, finally separating to feed independently on different parts of the leaf. As they grow older and stronger they devour the entire leaf with the exception of the midrib and larger veins. (Plate XX, Figure 1.)

In several cases under observation the eggs had been placed on old leaves and the young larvæ, not finding tender food, migrated to the tips of the shoots to feed on the tender leaves and bark thus causing the same injury as the beetles.

The larvæ are full grown in from 10 to 15 days and, after remaining comparatively inactive for a day or two, prepare for pupation. Plate XX, Figure 2, is from a photograph of a larva, natural size, and enlarged.

Pupation.— Pupation takes place above ground. When about to pupate, the larva attaches itself to the leaf by means of the sticky disc at the tip of the abdomen and allows its body to hang down. The head is gradually bent forward and the legs drawn up to the body. The transformation from the larva to the pupa takes place in a few hours. The pupa is retained in the larva skin.

The pupa.— The pupæ are familiarly known among the willow pupated growers as "hangers." Usually all of the first brood pupate by June 10. The pupæ are attached promiscuously to the

Plate XIX.

under surface of the leaves, usually upon the upper half of the willow or upon blades of grass or weeds growing in the willow rows. The are shining black on the anterior half and dark brown on the posterior. They vary in length but measure on the average, when first formed, about 9 mm. and are about one-third as broad on the anterior half, tapering from the middle to the posterior extremity. (Plate XX, Figures 3 and 4.)

As the time approaches for the mature insect to come forth, the outline of the pupa becomes more distinct. The posterior half which becomes an empty skin, shrivels and the true pupa stands out prominently. It is oval in outline, more or less obtusely rounded at each end, and measures about 6 mm. by 3.5 mm. The pupa stage lasts from 10 days to 2 weeks.

The mature insect.— The mature insects, beetles, vary in length from 5 mm. to 8 mm. and are a little more than half as broad as long. The general color is black and gold above and dark metallic green beneath. The head and thorax are black, the latter having broad lateral margins of brick-red partially interrupted at the middle by a more or less distinct black mark. The elytra are marked with black and gold, the black being in three interrupted longitudinal lines on each elytron. The lateral and posterior margins are brick-red. The inner margins are black and when the elytra are at rest form a broad, median line of black. The other markings on the elytra vary. In some individuals the gold predominates, while in others the black is more prominent.

The legs are brick-red and black, the former color usually prevailing on the posterior third of the femur and the anterior two-thirds of the tibia. The tarsi are marked more or less regularly with brick-red and black. Plate XX, Figure 5, is from a photograph showing the mature insect natural size and enlarged.

The beetles or "hard shells" as they are commonly known among willow-growers, are most numerous on the willows, about Syracuse, from the middle or latter part of June until the second or third week in July. During this time the willows grow rapidly, about three feet being a fair growth, and as the beetles feed vora-

ciously on the tender leaves and bark at the tips of the willow-whips, irreparable injury is done by causing them to branch as previously explained.

Hibernation.— By the 1st of August nearly all the beetles have left the willows and sought shelter in any convenient place. In the fields about Syracuse they could occasionally be found under stones but were more numerous under logs, under bark on trees and in the crevices in fence rails. In willow fields which have not been kept free from weeds and grass, the beetles find shelter down close to the roots or in the stools of grass. In these retreats they remain until the following spring.

NUMBER OF BROODS.

There are probably two broods and possibly three, but this point has not been satisfactorily settled. The writer failed to find eggs later than June 24th, and as the beetles retreat to winter quarters early in August, there is hardly time for more than two broods under the most favorable circumstances.

NATURAL ENEMIES.

Several species of *Coccinellidaé*, lady-bird beetles, and *Carabidaé*, ground beetles, are said to attack this insect in the undeveloped state. The eggs especially are devoured by the lady-bird beetles. Dr. Riley[5] states that he has observed a species of *Coccinellidae, Megilla maculata,* feeding upon larvæ and pupæ of this insect. Doubtless these natural enemies have been more or less active in the willow fields about Syracuse, but the writer did not observe an instance of this kind on any of the visits to the fields, and of several growers questioned, none had seen the predaceous insects.

METHODS OF COMBATING.

The principal methods employed by the willow-growers of this State in combating the cottonwood leaf beetle may be classified under two heads.

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[5] Insect Life, 3:43.

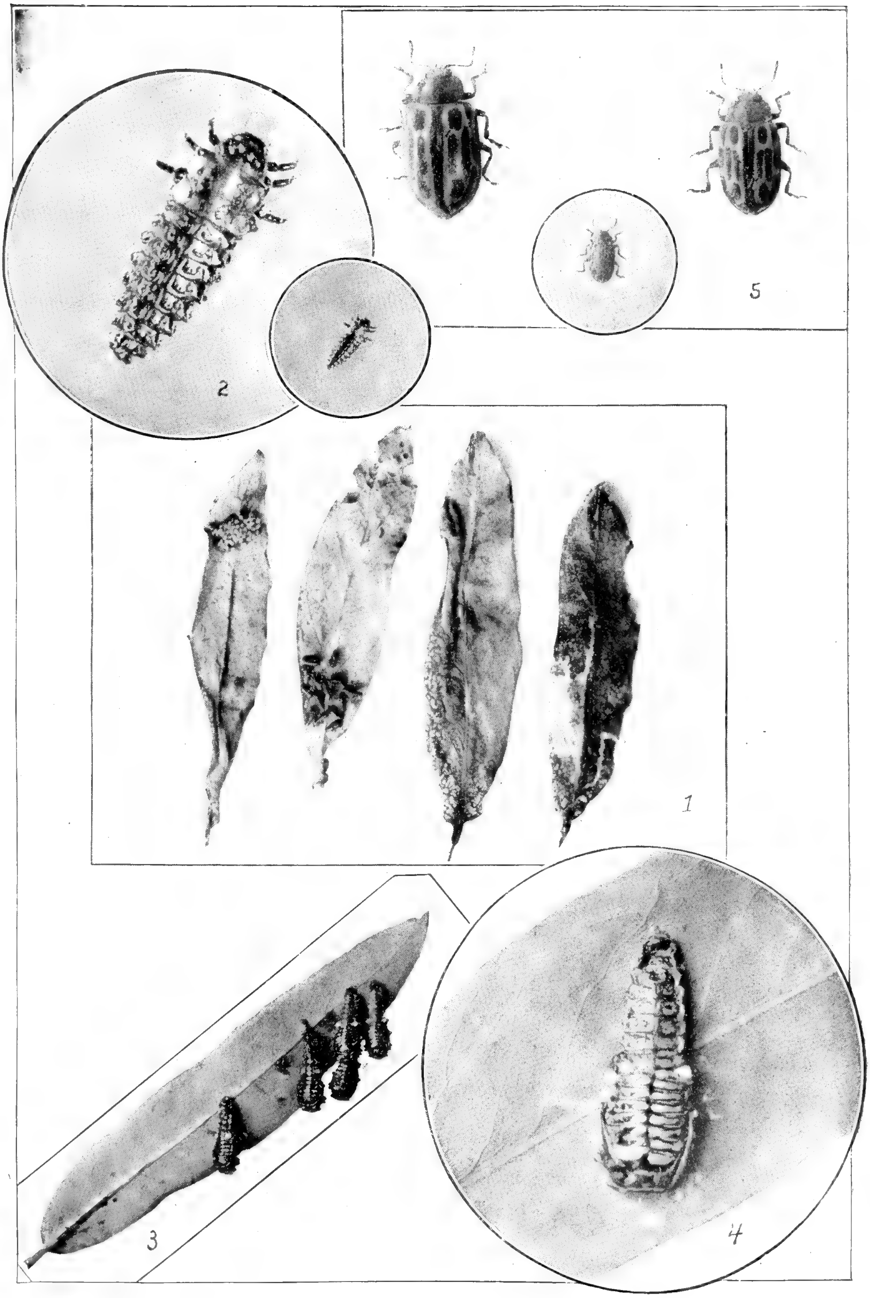

PLATE XX.

(1) *The application of poison or repellants to the willows, either dry or mixed with water.*— The poisons most commonly used are Paris green and London purple, applied either in water or mixed with lime or land plaster. Paris green and land plaster, about 1 part of the poison to 40 parts of land plaster, is considered an effectual remedy if applied when the willows are wet with dew or rain. A solution of copper sulphate without lime, 1 pound to from 7 to 12 gallons of water, has been tried by several growers about Liverpool, one of the willow-growing centres near Syracuse, but without much success. If applied strong enought to materially check the insect, it injures the willows.

None of the above compounds have proven uniformly satisfactory in the hands of the willow-growers.

(2) *By using machines for catching the beetles.*— These machines are made for use with either horse or hand-power. The two forms are illustrated at Plates XXI, XXII and XXIII which are from photographs taken by Mr. Rogers of Liverpool, at the writer's request. The dimensions of the body of the horse-power machines are as follows: Length 5 feet, width of rear end 2 feet, front end 1 foot 8 inches, depth 6 inches. The body thus forms a shallow tank which may be lined with zinc or tin and in which kerosene oil or kerosene oil and water, the oil forming a thin film on the surface of the water, should be kept while the machine is in use. A number of narrow strips are placed longitudinally over the top in the manner shown in Plate XXI to keep the willows from touching the oil. Two stout runners fastened to the under side support the tanks. Plate XXII shows the machine in position ready for use. As will be observed, it is made to run between the rows; the long arms which extend obliquely from either side, cause the willows to bend over as the machine moves along and at the same time rub off the beetles and many of the larvæ and pupæ which drop into the tank and are quickly killed by the oil. A lighter machine for hand-power is shown at Plate XXIII.

Of the two classes of methods used in combating this insect, the latter has proven much more satisfactory; but unfortunately owing to the small size of the willows, the machines cannot be used to advantage early enough in the season to prevent serious injury by the beetles which first appear in the spring and also by the young larvæ as they are not as readily dislodged.

In order to ascertain if possible whether the insect could be satisfactorily held in check by the application of an arsenical poison, thus providing a way to stop the injury to the willows early in the spring before the machines can be used to advantage, the following experiments were undertaken.

EXPERIMENTS.

The experiments were continued through two seasons, beginning in the spring of 1896. Through the kindness of Mr. Joseph Kennedy, of Liverpool, N. Y., a field of about an acre of willows on his farm was reserved for the experiments. Green arsenite and arsenate of lead were the poisons selected the first year as being most likely to prove satisfactory.

The green arsenite was used at the strength of 1 pound to 150 gallons of lime water and the arsenate of lead, 1 pound to 45 gallons. For the first spraying on two of the plats, 2 quarts of glucose was added to each 45 gallons of the mixtures and for the second spraying the same amount of thin glue.

The treatment which each plat received the first year is shown in the following diagram:

DIAGRAM OF PLATS IN 1896.

Dates of sprayings.	Plat I	Plat II.	Plat III.	Plat IV.
June 5.	Green arsenite.	Green arsenite and glucose.	Untreated.	Arsenate of lead and glucose.
19.	Green arsenite.	Green arsenite and thin glue.	Untreated.	Arsenate of lead and thin glue.

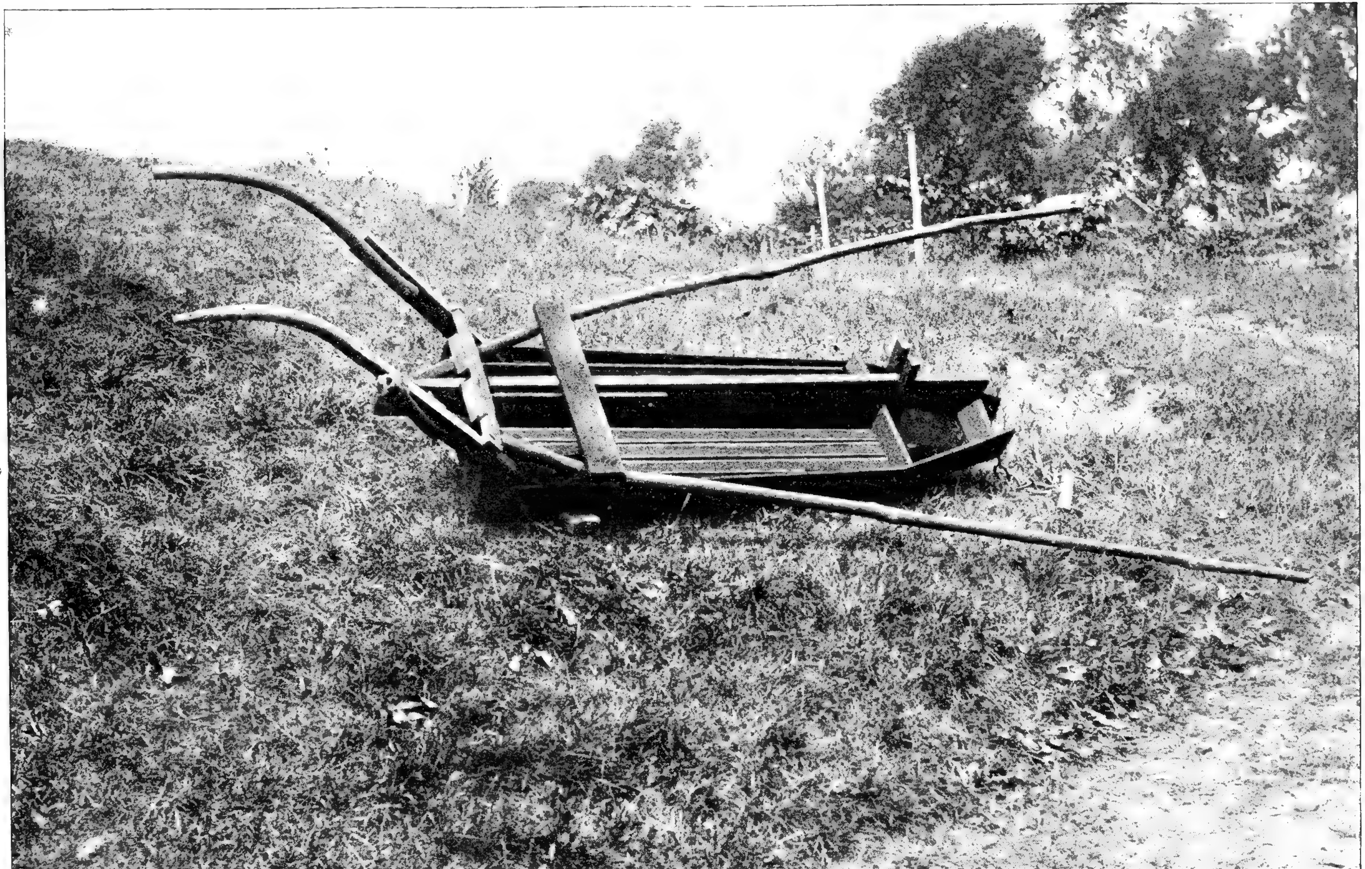

Plate XXI.

Experiments in 1896.— As shown in the table, the plats were sprayed but twice in 1896. Unfavorable weather prevented a third spraying until too late to be practicable and the machines for catching the beetles were used twice, about seven days apart, after the last spraying. For these experiments a knapsack sprayer was used to apply the poison. When lime was used, enough of the freshly-slaked lime was added to make the mixture slightly milky in appearance.

Results in 1896.— It was difficult to obtain exact results in this case. Swarms of beetles came from other fields to the sprayed plats. The general indications were that the plats sprayed with green arsenite mixed with lime water and glue and with arsenate of lead and glue were less injured after the second spraying than the other plats. About 80 per cent of the willows on these plats were uninjured by the beetles, while on Plat III, the check plat, at least 50 per cent were damaged. Glucose did not prove as successful in making the mixture adhere to the leaves as thin glue, but glue was found to be impractical for this purpose because of sticking in the pump and clogging the nozzle.

Experiments in 1897.— The plan of the experimental field was changed for these experiments and a Peppler horse power sprayer used in place of a knapsack. As shown by the diagram the acre was divided into two equal plats and both plats sprayed on June 3.[6] The machine for catching the insects was not used on either plat. Plat II received but one application of the poison while Plat I was sprayed as shown in the following diagram.

The green arsenite was used at the strength of 1 pound to 100 gallons of lime water. Whale oil soap, 1 pound to 20 gallons of the mixture, was added to make it spread upon the leaves. Whale oil soap also doubtless acts as a repellant to the insects and may be used much stronger.

[6] The original plan was to leave Plat II unsprayed but through a misunderstanding it received one application of the poison.

DIAGRAM OF PLATS IN 1897.

Dates of spraying.	Plat I.	Plat II.
June 3.	Green arsenite and whale oil soap.	Green arsenite and whale oil soap.
13.	Same	Untreated.
23.	Same	Untreated.
Results ...	Marketable willows, 2 tons.	Marketable willows. 1 ton.

Results in 1897.— Comparatively few beetles came from neighboring fields and hence the results were more satisfactory than in 1896. As shown in the diagram the yield of the half acre which was sprayed three times was twice that of the half acre sprayed but once.

The results of spraying alone as a means of combating the beetles, compared with depending entirely upon the machines for catching the insects, may be shown by comparing Plat I to a near-by field upon which the machines alone were used. The conditions were practically the same in both cases and the yield was about the same but there was a decided difference in the cost of treatment. In the field referred to, a machine was kept running a part of every day for nearly three weeks, which is not exceptional, at a cost of $4.05 per acre for labor while the cost of spraying, with a power sprayer covering six rows, was but $2.58 per acre for labor and materials for the three applications. Thus the expense of spraying was but little compared to the yield and much less than the cost of running the machines long enough to produce the same results.[7]

[7] In the field referred to the machines were used but once a day throughout the entire three weeks. Usually it is necessary to go over the fields twice a day for a week or ten days, thus increasing the expense.

PLATE XXII.

SHOULD SPRAYING ALONE BE DEPENDED UPON IN COMBATING THIS INSECT?

Although the results in the above experiments are very gratifying in favor of spraying, in many seasons it will be found impractical to depend upon this means alone in combating this insect. Usually the willows are too large before time for the third treatment to spray to the best advantage and hence the machine should be brought into use for a short time if necessary. On newly-planted fields, however, spraying will be found of special advantage in keeping off the insects while the willows are getting a start and before they are high enough for the machines.

IMPORTANCE OF A UNITED EFFORT OF THE WILLOW GROWERS.

Insects which migrate as readily as the cottonwood leaf beetle will quickly spread over a community where their food plant is extensively grown. The adults of this species fly readily and probably for quite long distances. In the fields about Syracuse, they literally swarm upon the willows, coming from all directions, especially from neglected fields, which of late years are becoming common in this community. A neglected field of willows means that the beetles will breed there unmolested and as food becomes short or as migratory instincts dictate, will seek other fields in the vicinity. Several illustrations of this kind came to the writer's notice at Liverpool. Willow growers whose fields were in the vicinity of neglected fields suffered greater loss from injury to the willows, or were put to greater expense in combating the insect than were those whose neighbors united with them in an effort to check the pest.

RECOMMENDATIONS.

Begin spraying early in the season. Make the first application before the beetles become numerous and follow it by one or two more a week or 10 days apart.

Use green arsenite or other equally good arsenical, 1 pound to 100 gallons of water, with the addition of enough freshly-slaked lime to make the mixture slightly milky in appearance. One pound of whale oil soap to about 20 gallons of the mixture may be added with good results. It will do no harm to use the soap stronger.

Spray newly-planted fields with the poison until the willows are large enough for the machines.

After the willows are too high to spray thoroughly by ordinary means, use the machines for catching the insects if necessary.

Urge the importance of a united effort on the part of all interested in willow growing.

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II. GREEN ARSENITE.*

V. H. Lowe.

SUMMARY.

Green arsenite is a simple arsenite of copper similar in texture and chemical composition to Scheele's green. It is as poisonous as Paris green, is cheaper to manufacture, and is an impalpable powder instead of crystalline, hence it will remain suspended in water longer than ordinary Paris green thus insuring a more even application to the foliage. It should be used with lime in the same manner as Paris green.

INTRODUCTION.

Under the name green arsenite the Adler Color and Chemical Works have placed upon the market an arsenical which may be used in place of ordinary Paris green. As stated in the Fifteenth Annual Report of this Stattion, pages 536-539, samples were sent to the Station in 1896 for experiment. During 1897, two other samples were sent for the same purpose. In addition to the experiments the poison has been extensively used in place of Paris green in the Station orchard during the past two seasons with excellent results.

QUALITIES AND USE OF GREEN ARSENITE.

NATURE AND COMPOSITION.

In general appearance green arsenite resembles ordinary Paris green. It differs chemically from this poison in being a simple

*Reprint from Bulletin No. 143.

arsenite instead of an aceto-arsenite of copper, and physically in being an impalpable powder while Paris green is crystalline.

Green arsenite is said to be similar to if not identical with Scheele's green, but according to samples sent by the manufacturers to the Station the percentage of arsenious oxide may vary from 41.04 to 62 per cent, while Scheele's green contains, theoretically, 52.94 per cent.

WHEN FIRST USED AS AN INSECTICIDE.

Mr. C. L. Marlatt of the United States Department of Agriculture, Division of Entomology, was probably the first to use green arsenite in place of Paris green. Mr. Marlatt[8] states that copper arsenite (green arsenite) was especially made for him in 1894, by a prominent manufacturer of Paris green and that it is in reality Paris green, without the addition of acetic acid which is added to produce a more or less coarsely crystalline product.

In a publication of the Department of Agriculture, Mr. Marlatt[9] gives the results of experiments with this insecticide. He found that the action of the simple arsenite of copper on the foliage of various plants used in the experiments was practically the same as Paris green. Again in a subsequent bulletin[10] Mr. Marlatt gives results of experiments with this and other arsenicals.

ADVANTAGES OF GREEN ARSENITE OVER PARIS GREEN.

In addition to the comparatively low cost of manufacture the principal advantage of green arsenite over Paris green is that, as it is so much more finely divided, it remains in suspension in water much longer. From experiments in the laboratory the writer found that the ordinary crystalline Paris green, when mixed with water at the rate of 1 pound to 150 gallons, would sink to the bottom of the jar in about five minutes, leaving the

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8 Insect Life, 7: 408–411.
9 U. S. Dept. Agr., Div. Ent., Bul. 2, n. ser.
10 U. S. Dept. Agr., Div. Ent., Bul. 6, n. ser.

water clear, while the green arsenite remained in suspension for over two hours.

It is because the green arsenite stays suspended in water so much longer than Paris green, that it is more valuable as an insecticide. Without doubt much of the failure to get good results from Paris green is because of the difficulty of keeping it evenly distributed through the tank. Unless the mixture is almost constantly agitated, the Paris green sinks to the bottom and is quickly drawn out by the pump, so that before the tank is half empty most of the poison is gone and the remainder of the water contains so little Paris green as to be hardly worth applying.

HOW TO USE GREEN ARSENITE.

Green arsenite should be used the same as Paris green. For ordinary purposes use 1 pound to from 100 to 150 gallons of water with the addition of enough freshly-slaked lime to make the mixture slightly "milky" in appearance. Lime should always be added, for, in addition to other uses, it prevents injury to the foliage. It may be used with Bordeaux mixture in the same manner as Paris green.

PRICE PER POUND AND WHERE OBTAINED.

Green arsenite can be obtained from the Adler Color and Chemical Works, New York, and probably from other leading dealers in similar products for 15 cents per pound.

EXPERIMENTS WITH GREEN ARSENITE.

No strictly comparative experiments with this insecticide have been made here at the Station. Comparative tests[11] by C. L. Marlatt, however, indicate that green arsenite and Paris green are equally effective as insecticides.

Experiments with green arsenite made by the writer are recorded on pages 600-601 of Bulletin 136 of this Station and on

[11] U. S. Dept. Agr., Div. Ent., Bul. 6, n. ser.: 30–35.

previous pages of this Report. In the former instance the insecticide was successfully used against a flea beetle, *Systena hudsonias* Forst. attacking young apple grafts, and in the latter with equal success against the cottonwood leaf beetle, *Lina scripta* Fab.

In the spring of 1896, and again in 1897, the writer used green arsenite against the spring canker worm in an orchard near the Station. Fourteen large bearing apple trees were used in the experiments. Both seasons the trees were sprayed three times, the first being about the middle of May and the remaining two from a week to ten days apart. In 1896 the remainder of the infested orchard was sprayed with ordinary Paris green, and in 1897 the green arsenite alone was used. In 1896, the trees sprayed with green arsenite were more uniformly free from canker worms than those sprayed with Paris green, while in 1897, the sprayed trees were practically free from canker worms after the second application, which was made May 22, while the unsprayed trees were nearly stripped of their foliage.

In addition to the above experiments the writer has used green arsenite upon young pear trees against the fruit worm and upon potatoes against the Colorado potato beetle. In both instances the poison was used at the rate of 1 pound to 150 gallons of water with the addition of enough freshly-slaked lime to make the mixture slightly milky in appearance, and gave every indication of being equally as efficient as Paris green.

EXPLANATION OF PLATES.

PLATE XVIII.— *Young willow whips injured by the cottonwood leaf-beetle.*

PLATE XIX.— *Uninjured willow whip and one which was injured at a early in season causing it to branch.*

PLATE XX.—*1. Willow leaves showing eggs attached and injury by young larvae. 2. Larva natural size and enlarged. 3. Pupae attached to willow leaf, natural size. 4. Pupa enlarged. 5. Beetles natural size and enlarged.*

PLATE XXI.— *Machine for catching the beetles.*

PLATE XXII.— *Machine in position ready for use.*

PLATE XXIII.— *Hand power machine.*

III. THE RASPBERRY SAW-FLY.*

Monophadnus (*Monophadnoides* Ashm.) *rubi* Harr.

Order Hymenoptera; family Tenthredinidæ.

V. H. Lowe.

SUMMARY.

During the past two years the raspberry saw-fly has done serious injury in certain localities in the State. The adult insects appear at about the time the leaves begin to expand. The eggs are placed just beneath the under cuticle of the leaf by means of the saw-like ovipositor with which the female is provided. The leaf tissue above the eggs becomes lighter in color, so that a leaf in which several eggs have been deposited has a spotted appearance. The larvæ are green in color and are covered with spine-bearing tubercles. They feed voraciously upon the leaves and may occasionally attack the tender bark of the new growth, the flower buds and the young fruit. Pupation takes place under ground, the larvæ forming oblong cocoons of a few coarse strands of silk together with a glue-like secretion mixed with particles of earth. The larvæ remain all summer and until the following spring in the cocoons, slowly changing to the pupa state. There is but one brood annually.

Experiments showed that the larvæ can be successfully checked either by brushing them off from the bushes to the loose soil between the rows or by spraying with hellebore, 1 ounce to the gallon of water. The latter method was found to be most practical especially in large fields.

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* Reprint from Bulletin No. 150.

INTRODUCTION.

In some sections of the State the raspberry saw-fly is at times one of the most troublesome insects with which the grower of raspberries and blackberries has to deal. Few if any of the numerous species of insects known to this State which attack these important crops are capable of doing more serious injury in a single season. Fortunately it is not a difficult insect to control and hence it is chiefly important that the farmers should learn the nature of the insect, how the presence of a brood can be detected while yet in the egg stage and the measures necessary to take in destroying the larvæ.

The investigations and experiments herein recorded were largely made on the farm of Mr. J. F. Mikelson of Oaks Corners, N. Y., to whom the writer is indebted for many courtesies shown.

GENERAL NOTES UPON THE INSECT.

CLASSIFICATION AND NAME.

As indicated by its name this insect belongs to the group of hymenopterous insects popularly known as the saw-flies, which in number of species and economic importance form the principal members of the group *Tenthredinidae.* The raspberry saw-fly was first described by Harris in 1850, who gave it the scientific name of *Selandria rubi.* It has recently been included by Ashmead in his new genus, *Monophadnoides.*[1]

The insects of this group are most destructive to garden and field crops of any of the *Hymenoptera.* They are, therefore, of much importance to the agriculturist, and hence it may not be out of place to review briefly the principal characteristics by means of which the more common saw-flies can be recognized in their various stages of development.

The egg.— The eggs should be looked for on the under surface of the leaf, usually near the midrib and larger veins. Sometimes

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1 Canadian Entomologist, 30:253.

they are placed in rows on the midrib and larger veins as in the case of the currant saw-fly, but more often the female makes a slit through the cuticle of the leaf and deposits her egg underneath. The eggs are usually quite small at first but it has been observed that they gradually enlarge, probably by the absorption of moisture from the leaf tissue.

The larva.— The larvæ of saw-flies resemble caterpillars in general appearance, but can usually be distinguished from them by the number of prolegs, which in most cases is from 12 to 16, while true caterpillars, with one exception, have but 10.[2] Also a common habit among saw-fly larvæ consists in curling the posterior segments of the body about the stem or edge of the leaf upon which they are feeding. Other species are slug-like in appearance. A familiar example is the cherry slug which attacks the leaves of both cherry and pear trees. In still other species the larvæ are smooth and free from slime or covered with spine-bearing tubercles.

The pupa.— The pupa is enclosed in a parchment-like cocoon. Some species form them 2 or 3 inches under ground, while others prefer the surface of the ground or some point on the food plant a short distance above it.

The adult.— The adult insect may be readily distinguished from other *Hymenoptera* by the broad head and thorax and the abdomen which broadly joins the thorax at its base. Other characteristics are found in the wings and the peculiar saw-like ovipositor of the female.

HISTORY AND PRESENT DISTRIBUTION.

But comparatively little is said about this species by the early writers on economic entomology. So far as the writer has been able to learn it is not mentioned as a European species. Among the earliest references to it is one by Harris in his "Entomologi-

2 Comstock's Manual for the Study of Insects, p. 612.

cal Correspondence," published in 1846, where Saunders[3] states that Darling, in a letter to Harris, "gives a correct account of the manner in which the egg is deposited." In 1850, in the *New England Farmer,* Harris published an account of the habits and ravages of this insect and the means to be used against it. From this time until 1869 there appears to have been nothing of importance published about it. In July of that year Walsh and Riley[4] published notes upon the life history of the insect, and gave an account of its ravages in Illinois. Since this time occasional references have been made, but little added to our knowledge of its life history and distribution. The most notable exception which the writer has been able to find is in a paper on "Insects Injurious to the Raspberry," by W. Saunders, published in the Annual Report of the Entomological Society of Ontario for 1873, pp. 11-12. In this paper Mr. Saunders gives a detailed description of the insect in all its stages except the pupa; but does not describe the adult male. Full notes are also given upon its life history.

The species probably has a wide distribution throughout the Eastern and Central States. It is known to occur in southeastern Canada, Vermont, Massachusetts, Connecticut, New Jersey, New York, Ohio, Michigan, Indiana, Illinois and Iowa. It is widely distributed in this State, being found on Long Island and at various points west along the central and southern part of the State nearly to the western boundary.

ECONOMIC IMPORTANCE.

Although this insect is capable of doing serious injury, often occurring in sufficient numbers to nearly ruin an entire crop of fruit, it is not difficult to check, and hence it is of less economic importance than many species more difficult to control. It should be borne in mind, however, that it is of especial importance to recognize the discolorations of the leaf caused by the presence of

[3] Ont. Ent. Soc. Ann. Rpt. 1873: 11.

[4] American Entomologist, 1: 224.

the eggs or the young larvæ when they first appear, so that the necessary steps can be taken to check the insect before serious injury is done.

Importance in the nursery.— This saw-fly is occasionally found in the nursery, where it may do much injury to the young blackberries and raspberries. The larvæ feed upon the new growth of the young tips after first devouring the leaves, and hence may do serious injury by checking the early growth of the plant.

FOOD PLANTS.

As its name indicates, this species feeds principally upon the raspberry. In a large field of raspberries near the Station where several varieties are under cultivation, and where the insect has been very abundant for nearly four years, the Shaffer bushes have suffered most injury each season. In addition to the raspberry, the blackberry and dewberry are subject to attack.

INJURY TO THE PLANT.

The first injury is caused by the female, which, as stated in detail on another page, deposits her eggs on the under side of the leaf, just beneath the cuticle. At first no apparent injury results, but within a few days the upper surface of the leaf immediately over the egg turns light green, and finally a light yellow color, the tissue becoming dry and somewhat withered. Thus a leaf in which a number of eggs have been placed soon becomes distinctly spotted and hence is easily detected. (Plate XXVI, Fig. 4.) Where a large number of eggs have been deposited on a single leaf nearly the whole leaf becomes lighter in color and appears somewhat wilted. This is a matter of importance to the grower, for by the spotted leaves one may be made aware of the presence of the immature brood before the more serious injury caused by the young larvæ takes place.

Injury to the leaves and new canes.— The first evidence of the work of the larvæ upon the leaves is the small irregular holes

which they make. All of the soft parts of the leaves are finally devoured, leaving only the midrib and larger veins. (Plate XXIV.)

When the bushes are badly infested the new canes also suffer severe injury. The young expanding leaves are first devoured and finally in some instances the bark and succulent wood of the new growth is injured. (Plate XXV.)

Injury to the buds and young fruit.— The injury to the buds and fruit is much less extensive than to the leaves. On the Shaffer raspberries, in the field previously referred to, small percentages of the buds and fruits were injured. In every instance the buds and fruits were only partially devoured, the larvæ usually eating away a portion from the side as shown at Plate XXVI, Fig. 1.

DESCRIPTIVE DETAILS.

DESCRIPTIONS AND LIFE HISTORY.

First appearance in the spring.— The time when the adults come out of the ground in the spring undoubtedly varies according to the season. During the past 2 years the adults were not observed in the vicinity of Geneva before May 10. Last spring they were very common by May 25.

The egg.— Egg laying begins soon after the adults appear. Last spring a few eggs had been laid by May 18. May 27 the eggs were abundant. They are deposited from the under surface of the leaf. The female makes a slight incision with her saw-like ovipositor (Plate XXVIII, to the right of Fig. 2) and forces the egg under the cuticle and close up to the leaf vein near which the incision is made. Plate XXVI, Fig. 2, is from a photograph of the under surface of a raspberry leaf showing the eggs, nearly ready to hatch, natural size. Fig. 3 is enlarged from a portion of the same leaf. (The engraver has made the eggs in this figure show more distinctly than natural.)

When first deposited the eggs measure about 0.8 mm. in length. In about 48 hours they have increased slightly in size and con-

tinue to grow, evidently by the absorption of moisture from the leaf tissue, until fully developed. As the egg increases in size the tissue about it gradually turns lighter in color, finally becoming yellow. Thus, as previously stated, the infested leaves soon become spotted on the upper surface. (Plate XXVI, Fig. 4.)

The egg when first removed from the body of the female has been described by Saunders[5] as approaching a "long oval in form, rather obtuse at the ends and attaining its greatest diameter a little before the middle. Color white, with a faint yellow tinge and a smooth, glossy surface, semi-transparent."

The fully developed egg, as it appears when removed from the leaf, is white or slightly tinged with yellow and nearly pear-shaped. The average measurement is 1.2 mm. by 0.6 mm. at the widest point. As with the newly deposited egg the enveloping membrane is smooth and semi-transparent, plainly showing the movements of the embryo within. The number of eggs deposited on a single leaflet may reach as high as 24.

Period of incubation.— The period of incubation may vary from 7 to about 10 days. Some of the specimens under observation hatched in about 7 days, but most of them were 10 or 11 days old before hatching. The eggs from which the larvæ have escaped are plainly indicated by the irregular hole in the side of the swelling.

The larva.— The larvæ measure, soon after hatching, 2 mm. to 2.3 mm. on an average in length. The body is nearly cylindrical, yellowish white or very pale yellowish green and well covered with spine-bearing tubercles. The spines are at first white, but gradually change to dark brown. Before the first molt the head is slightly darker and about one-fourth broader than the body. The dark brown eye-like spots just above each antenna are very conspicuous. With the increase in size and the succeeding molts the color of the body becomes a pale green and finally a decided green color; the dorsal spines turn darker brown. The

5 Rpt. Ont. Ent. Soc., 1873, p. 11.

body gradually assumes the characteristic wedge shape, but to a less degre than with many species of saw-flies.

The full-grown larva.— Length about 18 mm.; body tapering, broadest on anterior third where it measures 2.1 mm. Color light yellowish green to darker shades, usually imitating the color of the leaf upon which it is feeding. Head darker with distinct nearly round eye-like spot on either side and sparsely covered with long white hair. Mandibles black at tips; prolegs on joints 6-13. Body covered with spine-bearing tubercles arranged in double transverse rows. In each double row the anterior dorsal tubercles bear two spines and the posterior three.[6] Two dorsal tubercles on the first segment of the thorax bear 5; all the lateral tubercles bear 1 and 2 spines. Dorsal spines very dark or black, lateral spines pale green or white. The anal plate bears six simple and two bifid spines. (Plates XXVII, Figs. 1, 2 and 3.)

Habits of the larva.— The newly-hatched larvæ feed on the soft parts of the leaf but are soon large enough to eat oblong or irregular holes through the leaf. Finally, as previously stated, the entire leaf is devoured with the exception of the midrib and larger veins. When at rest upon the upper surface of the leaf they are quite inconspicuous owing to the similarity of color of the body and leaf. They continue feeding for 10 days or more, finally going into the ground to pupate.

Pupation.— Pupation takes place during the latter part of June. Last year nearly all of the larvæ in a badly infested field of raspberries near the Station had gone into the ground by June 29. When ready to pupate the larvæ crawl down the canes and wander about for a time, apparently seeking a suitable place to enter the ground. Some of them enter the ground close to the canes but large numbers were observed to go 2 or 3 feet from

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6 From other descriptions principally by Saunders (Ont. Ent. Soc. Ann. Rpt., 1873, p. 12) it appears that there may be exceptions to this arrangement, but in nearly 30 specimens examined by the writer no exceptions were observed.

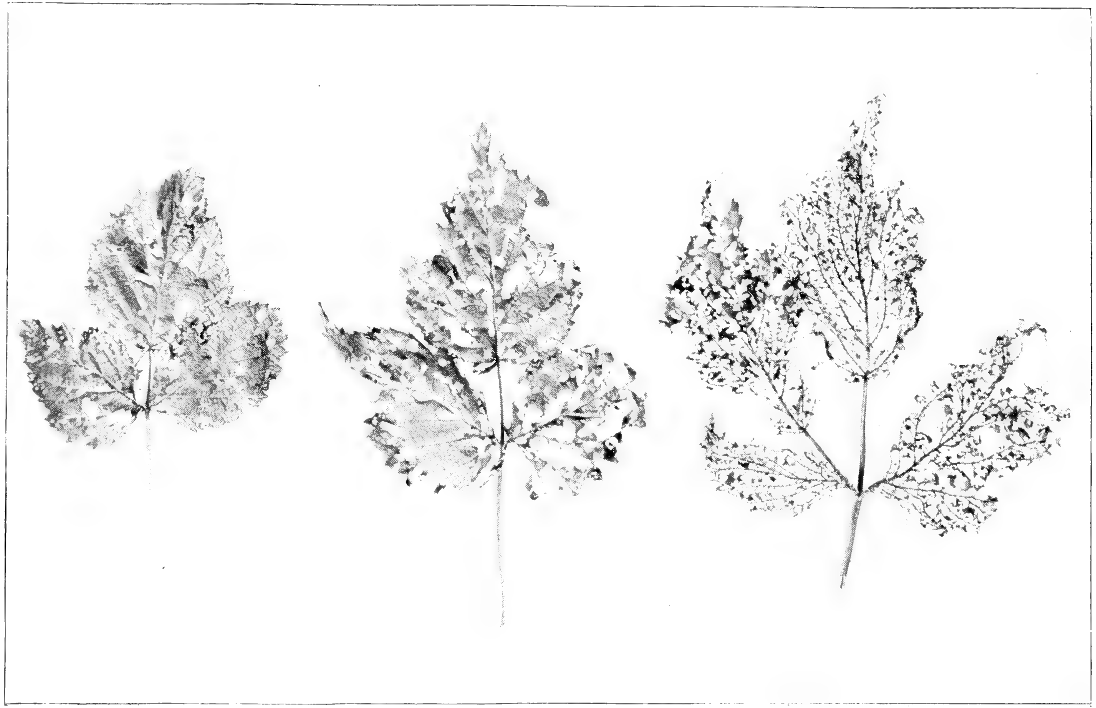

PLATE XXIV.

Plate XXV.

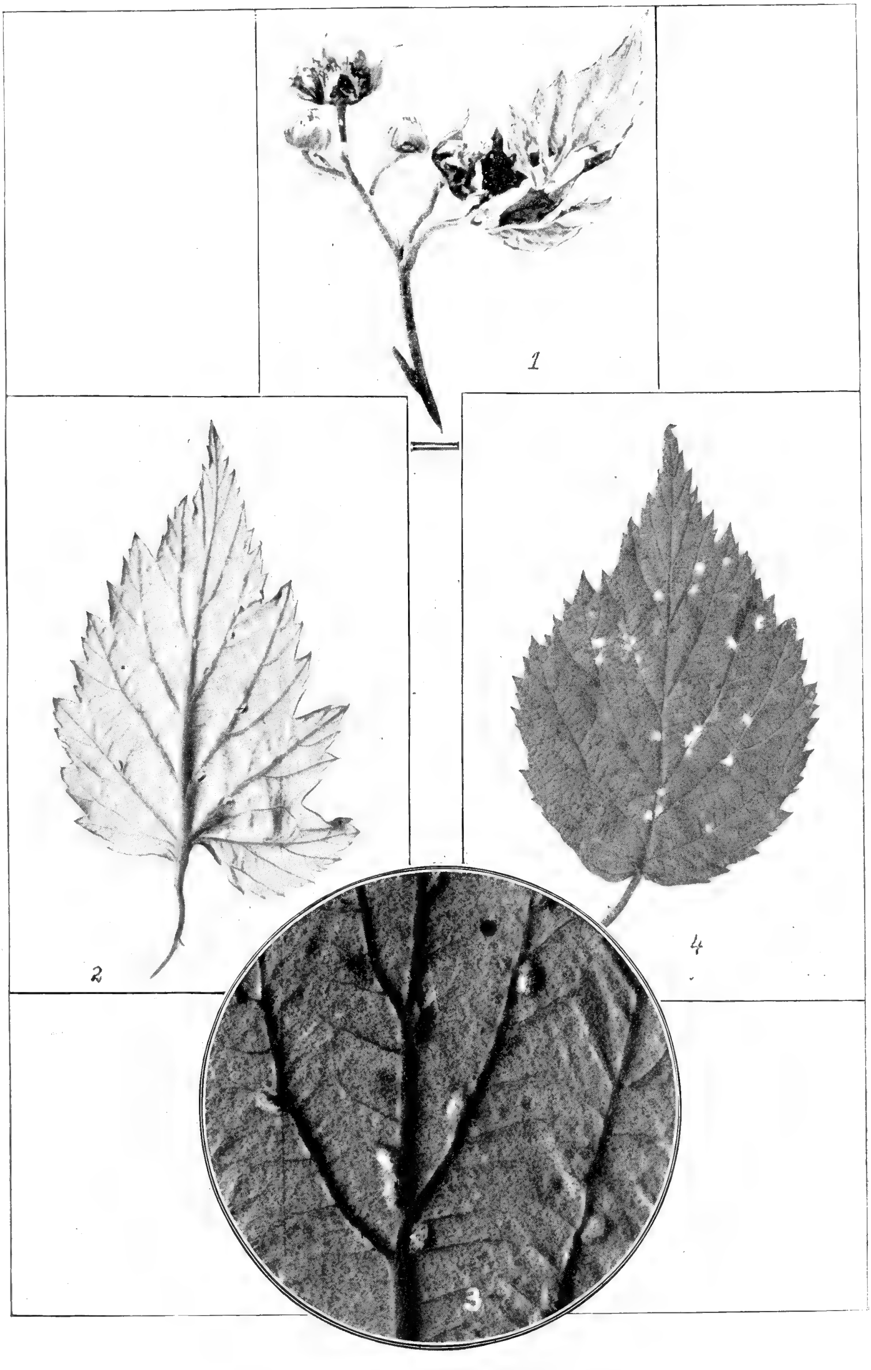

PLATE XXVI.

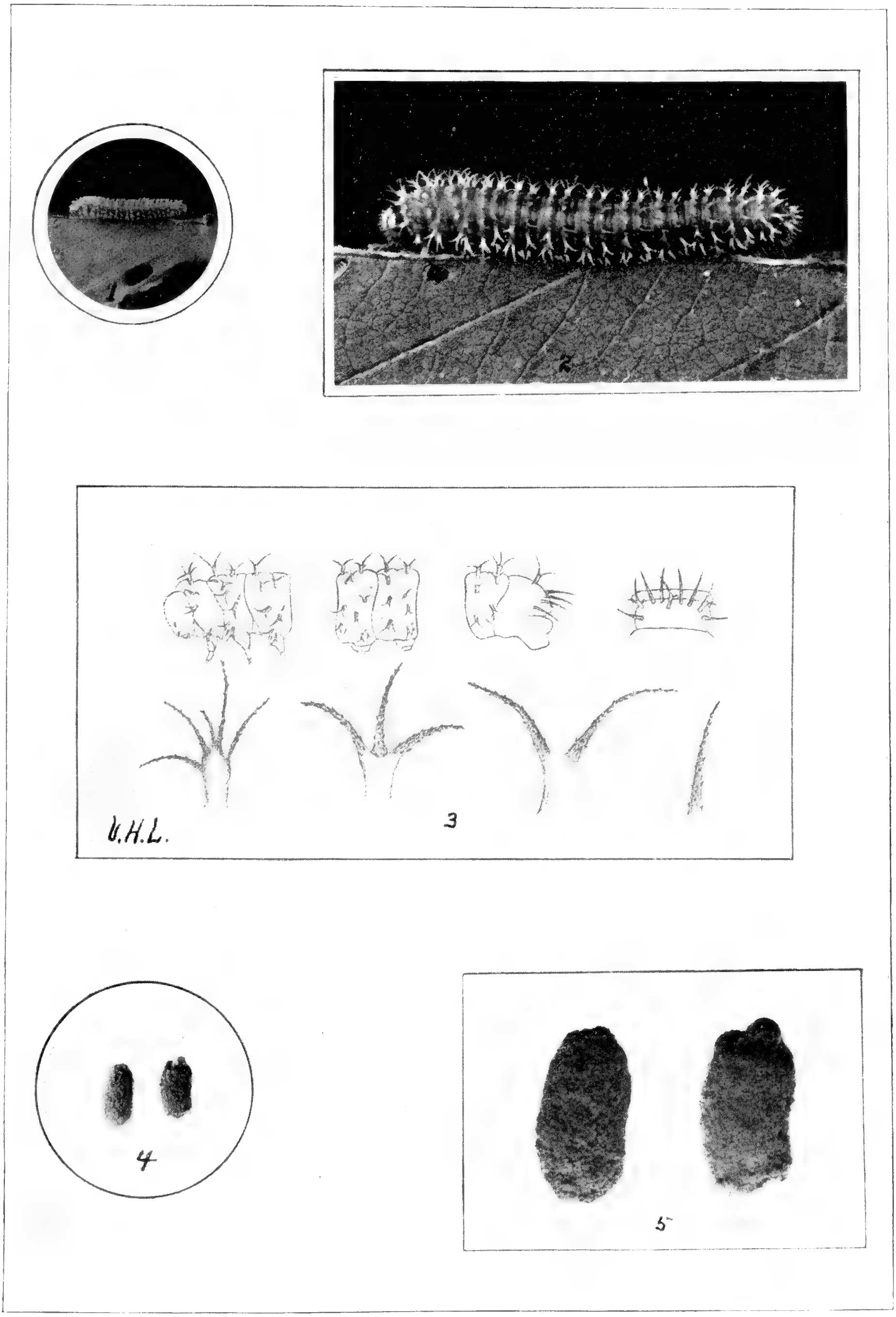

PLATE XXVII.

the base of the bushes before going into the ground. Also later in the season more of the cocoons were found about 2 feet from the bushes than close to the base. The cocoons are formed from 2 to 3 inches below the surface of the ground.

The cocoon.— The cocoons are not easily recognized owing to their close resemblance to the surrounding earth. They resemble an oblong, nearly cylindrical pellet of earth rounded at both ends and about 7 mm. long and half as broad. (Plate XXVII, Fig. 4, natural size, Fig. 5 enlarged.) One cocoon is broken at one end, showing the head of the imprisoned larva. The cocoons are largely composed of a dark-brown, mucilaginous substance to which the surrounding particles of earth adhere and which upon hardening becomes brittle and shining. It is insoluble in water, weak acid or alkali. Running through this substance and sometimes within the cell are occasional strands of coarse, brown silk. Thus it appears that the larva first spins a coarse network of silk to partially support the sticky mucilage in process of hardening. Although none of the larvæ under observation were noticed to molt or otherwise shed their spines before entering the ground, no trace of the spines could be found in the cocoons.

Within this tight, almost waterproof cocoon, the transformation to the pupa state slowly takes place. At first there is but little change in the appearance of the imprisoned larva, except that it is not covered with spines as formerly, but within 2 or 3 days has shrunken somewhat and become rigid and motionless. It remains in this condition all summer and all the following winter, slowly assuming the shape of the pupa. The transformation is finally completed during the latter part of March or in April. Specimens kept in moist earth in the laboratory pupated early in April.

The pupa.— The true pupa stage lasts but a few days. The pupa is pale green in color, becoming darker a few days before the mature insect emerges.

The manner in which the pupa escapes from the cocoon was not satisfactorily observed. It was noticed, however, that old cocoons, which had remained in the ground over winter, became soft and spongy and hence easily broken. Also that from the cocoons from which the adult insects had emerged a large irregular piece had been partially cut, as if by the jaws of the insect, and broken off from the end.

The adults.— As previously stated the adult insects appear about May 10. They fly actively about during the heat of the day, but in the early morning and toward evening or during unusually cool days they seek shelter on the under side of the leaves, remaining sluggish until warmed by the rays of the sun.

The female.— The following technical description is taken from Mr. Edward Norton's monograph[7] of the *Tenthredinidae:*

"Color black, head rather rugose, nasus somewhat incurved; head pubescent except about ocelli; mandibles with 2 stout inner teeth; tegulæ, most of anterior angle, the third, fourth, fifth and part of sixth seguments of tergum yellowish white, venter ferruginous; legs paler, their coxæ and basal half of femora and tips of posterior tibiæ blackish; inner claw tooth large. Wings smoky, hyaline, nervures brownish; marginal cross nervure curved and received near apex of third cell."

Four specimens examined by the writer corresponded to his description except in the color of the seguments of the tergum. In each of these specimens the second joint, as well as the third, fourth, fifth and part of the sixth seguments, is yellowish white. There is, however, slight variation in the markings which indicates that the difference in the markings of these specimens and those described by Mr. Norton is probably one of variation. The four specimens varied from 5 mm. to 6 mm. in length. (Plate XXVIII, Fig. 2.)

The male.— Length 4.5 mm.; black, tegulæ and dorso-lateral margins of collar yellowish white; middle and posterior legs

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[7] Trans. Amer. Ent. Soc., 1: 250.

darker than female, posterior femora black except at tips, wings somewhat clearer; abdomen more slender than female and wholly black. (Plate XXVIII, Fig. 1.)

NUMBER OF BROODS AND PERIOD OF ACTIVITY.

By noting the life history as previously given it will be observed that, in western New York, this species has but one brood annually. As the adult insects do not come out of the ground until the latter part of April or early in May and they and their progeny have disappeared by the first of July, the active life of the insect is at most of only about two and a half months duration, the remainder of the time being spent in the snug retreats under ground.

NATURAL ENEMIES.

This species seems to be peculiarly free from parasitic or predaceous insect enemies. In none of the literature relating to the insect is there an instance given of the presence of a parasite or the work of a predaceous species. Although a large field of raspberries badly infested with this insect was carefully watched last season, and several hundred of the larvæ brought to the insectary and confined in breeding cages, but one case of parasitism was found. Yet it is true that this insect sometimes suddenly disappears, after doing serious injury in a community for 3 or 4 consecutive seasons, as if suddenly checked by some parasite insect or other enemy.

METHODS OF COMBATING.

There are three principal methods of combating this insect, as follows: Jarring or brushing from the bushes, fall cultivating and the application of an insecticide either dry or as a spray.

Jarring or brushing from the brushes.— While studying this insect in the field it was noticed that the larvæ could be easily shaken from the bushes either by a sudden blow to the canes or by otherwise jarring the leaves. A heavy branch from which the leaves and twigs have not been removed or a pine switch with a

large tuft of needles at the end are convenient instruments for jarring or brushing the bushes. To make this work more effectual the soil between the rows should be kept well cultivated and free from weeds. The work should be done during the heat of the day when the soil is dry and crumbles easily. It should be the aim of the operator to brush the larvæ so that they will fall between the rows as far from the bushes as possible, the object being to make them fall on the loose earth where many of them will die from exhaustion in an attempt to return to the vines. Mr. Mikelson, who has tried this method, says that he met with good success. His soil is a light, sandy loam. Where children or other cheap help can be employed, this method is probably cheaper than spraying. If only a few bushes are infested it is a quick and easy method of checking the pest.

Fall cultivating.— The object is to bring the cocoons to the surface of the ground where they will be exposed to the weather. As a fair percentage of the cocoons are found from a foot to two feet from the bushes, some good could probably be done in this way, but the method needs further testing.

Spraying.— Two kinds of insecticides may be used in a spray against this insect, namely, arsenical compounds and hellebore. Both are efficacious, but hellebore is usually preferred, because of the prejudice against the use of arsenicals on rapidly developing small fruits and because hellebore does not disfigure either fruit or leaves.

Experiments.— A large field of raspberries belonging to Mr. Mikelson, which was badly infested with this insect, was divided into three plats for the purpose of the experiments. Plat I was sprayed June 4 with arsenite of lime, 1 pt. of the stock solution to 40 gallons of lime water; Plat II with hellebore, 1 oz. to 1 gallon of water; Plat III was left unsprayed.

Results.— On the second day after this application practically all the larvæ were dead on the sprayed plats. On Plat I the leaves were seriously injured, but as subsequent experiments with

Plate XXIX.

this arsenical showed no injury to the leaves it is possible that the compound was not properly prepared. Further experiments with this compound are needed. No more larvæ appeared on the sprayed bushes so that a second application was unnecessary.

Plat III, which was unsprayed, was nearly stripped of its leaves before the season was over, so that but little first-class fruit was developed. Plate XXIX is from a photograph taken in the field. The bushes on the left were sprayed with hellebore, those on the right were unsprayed.

Dry application of hellebore.— Powdered hellebore may be applied pure or mixed with twice its weight of cheap flour or land plaster. It should be dusted on early in the morning or in the evening while the leaves are moist with dew. The principal objection to this method is the difficulty of applying to the under surface and in making it adhere to the leaves.

RECOMMENDATIONS.

The treatment for this insect and insects of this class is usually a very simple matter. As indicated by the above experiments the prompt application of hellebore will check them, and in the case of this species, brushing the larvæ off from the bushes can be made effective. Where a spraying machine can be had it will be found that a more thorough application can be made with the spray. Make the applications thorough, drenching both upper and under surfaces of the leaf.

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1887. Webster, F. M. Trans. Ind. Hort. Soc., p. 107. Briefly mentioned.

Weed, C. M. Ann. Rept. Ohio Agrl. Exp. Sta., pp. 155–156. Brief notes; remedy, hellebore.

1889. Weed, C. M. Bul. Ohio Agrl. Exp. Sta., Vol. II, No. 1 (2d series), p. 5. Brief notes.

Townsend, Tyler. Insect Life, II, 2, p. 42. Mentions *Selandria (Monophadnus) rubi* as being abundant in the vicinity of Constantine, St. Joseph Co., Mich., from 1881–1886.

1891. Weed, C. M. Ann. Rept. Columbus Hort. Soc. for 1890.

1892. Smith, J. B. Insect Life, V, 2, p. 96. Injuriously abundant in some sections of New Jersey in 1892, although not common the year previous.

Ibid, Ann. Rept. N. J. Agrl. Exp. Sta., 1892, pp. 459–461.

Webster, F. M. Bul. 45, Ohio Agrl. Exp. Sta., pp. 154–155. Brief review of early literature; notes on life history and habits.

Kellogg, V. L. Common Injurious Insects of Kansas, pp. 93–94. Describes larva and adult and gives life history. Remedies, hand picking, white hellebore applied dry or in a spray.

1895. Davis, G. C. Bul. 121, Mich. Agrl. Exp. Sta., p. 56. Brief notes. Sometimes quite destructive in Michigan. Remedies, hellebore and arsenites.

IV. PRELIMINARY NOTES ON THE GRAPE VINE FLEA BEETLE.*

V. H. Lowe.

SUMMARY.

The grape vine flea beetle has been unusually abundant during the past season. The adults feed on the swelling buds, and to a certain extent upon the leaves. The principal injury to the leaves is by the larvæ. Experiments with this insect are not yet completed. The adults have been checked, however, with Paris green, at the rate of 1 pound to 50 gallons of water, with the addition of enough freshly slaked lime to make the mixture milky in appearance. This mixture should be applied to the vines in a fine spray as soon as the adults appear. Later applications against the larvæ may be made with Paris green, 1 pound to 150 gallons of lime water.

INTRODUCTION.

This insect was unusually abundant in the grape growing sections of the State last year. In the Keuka Lake region it was estimated by an extensive shipper that at least 10 per cent of the crop was destroyed last season. Some of the large vineyards in the vicinity of Bluff Point were entirely stripped of their foliage, with the result that no grapes were produced and the vines were much weakened.

As a result of this unusual injury numerous requests have come to the Station asking for information concerning the life history of the insect, and what should be done to prevent serious injury another year. Although the investigations and experiments in this direction are not yet completed, it seems advisable

* Reprint from Bulletin No. 150.

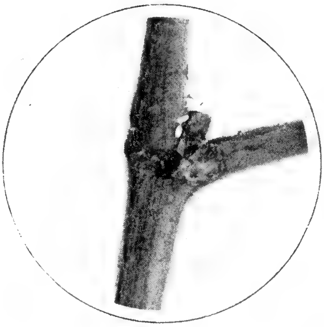
under the circumstances to review briefly the life history of this insect, and state the methods of combating it which have thus far been found successful.

LIFE HISTORY AND DESCRIPTIONS.

The adults.— The adult insects are shining steel blue flea beetles measuring about one-fifth of an inch in length. (Plate XXX, Fig. 3, *a*.) They jump quickly upon being disturbed. This flea-like habit has given them their name. They live during the winter in rubbish about the field or under the loose bark of the old vines. Last year they were active before the middle of April, and soon began feeding voraciously on the buds. So severe was this attack in some of the Keuka Lake vineyards that nearly all of the first and second buds were destroyed.

The egg.— Eggs are laid during the latter part of April or early in May. It is the commonly accepted statement that the eggs are placed in clusters on the under side of the leaves. From the writer's observations there appear to be many exceptions to this, if indeed it is usually the case. A number of beetles which were kept in a breeding cage in the insectary deposited all of their eggs near or upon the buds or in the angles at the base of the leaf stem as shown at Plate XXX, Figs. 1 and 2. The eggs were not deposited in clusters but singly. Although it was late in the season before field observations were made the eggs then found had been placed singly, either at the base of the buds or, occasionally, upon the upper or under surface of the leaves. Most of the eggs probably hatch early in May.

The larva.— The young larvæ are dark brown in color. At first they devour only the soft parts of the leaf, but finally eat clear through the tissue, making irregular holes. They are full grown in about four weeks. The full grown larva measures nearly one-fourth of an inch in length and is lighter brown than when first hatched. The head is black and each segment of the body is distinctly marked with shining black dots and patches from



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FIGS. 1 AND 2 OF PLATE XXX.

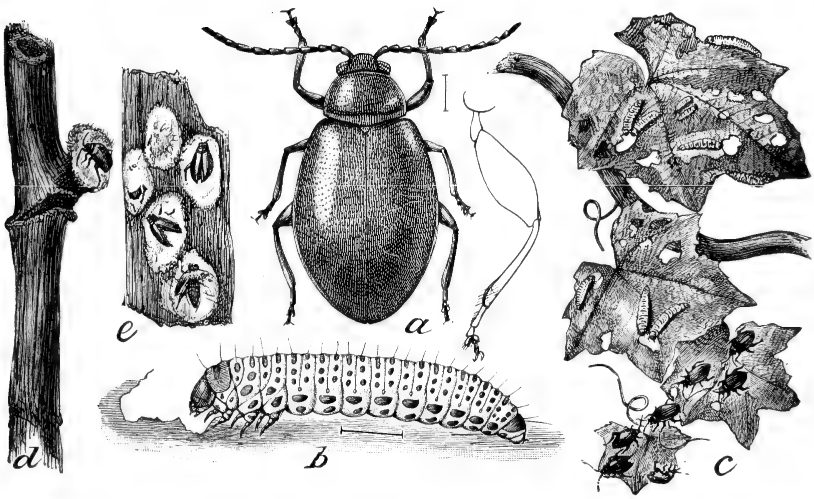

PLATE XXX.—(LOWER FIGURE.)

each of which one or more brown hairs arise. By the middle of May they have attained full size.

Pupation.— When ready to pupate the larvæ leave the vines and enter the ground to a depth of 2 or 3 inches to transform to the pupa state. The adults appear during the latter part of June or early in July.

The adults.— The adults feed all summer, finally seeking a refuge in which to pass the winter and coming forth in the spring in time to attack the buds as previously indicated. Probably some of the adults lay a few eggs during the summer for both larvæ and eggs were occasionally found last season as late as July 14. The larvæ varied in size from newly hatched to nearly full grown.

METHODS OF COMBATING.

Numerous remedial measures have been suggested and some of them tried. They include scattering air slaked lime or unleached ashes about the base of the vine to kill the larvæ as they attempt to enter the ground, spreading sheets of cloth saturated with kerosene oil on the ground under the vines and jarring the beetles upon them, and spraying the vines with kerosene emulsion or an arsenical poison to kill the larvæ.

Spraying with an arsenical poison.— The prompt and thorough application of an arsenical poison is probably the most effectual and practical method of controlling this insect, especially in large vineyards. Paris green is usually used. It is not improbable that arsenite of lime would be equally effectual and cheaper. If Paris green is to be applied, use 1 pound to 50 gallons of water with the addition of enough freshly slaked lime to make the mixture milky in appearance. Make the first application a short time before the buds begin to swell or as soon as the beetles are found on the vines. The object of this first application is to cover the buds with poison so that the beetles which eat into them will be poisoned by the Paris green. It will usually be found necessary

to make a second application against the larvæ when they first appear on the leaves. In this case use the Paris green at the usual strength, 1 pound to 150 gallons. If Bordeaux mixture is to be applied the Paris green or other arsenical may be mixed with it in the same proportion as with water.

In combating this insect it should be remembered that prompt and thorough work is absolutely necessary to ensure success. The spray should be fine enough and so directed as to cover as many of the buds as possible and when applied to the leaves both upper and under surfaces should be wet.

IMPORTANCE OF UNITED EFFORT.

The grape vine flea beetle is one of the species which migrates readily from one field to another. A neglected vineyard may serve as a breeding place for large numbers of the beetles which will in time infest other vineyards in the vicinity. This was well illustrated last season in several Keuka Lake vineyards which came under the writer's observation. Some of the vineyardists who were in the habit of carefully spraying their vines had much of their good work undone by the large numbers of beetles which came from neglected vineyards nearby where food had become scarce. From this it is evident that if this insect is to be checked in communities where they have become abundant, every vineyard should be carefully watched and the vines promptly sprayed when the invaders appear.

EXPLANATION OF PLATES.

PLATE XXIV. *Leaves showing injury by young and adult larvae.* From a photograph. (Original.)

PLATE XXV. *New canes of Shaffer raspberry nearly denuded of foliage by the saw-fly larvae.* From a photograph. (Original.)

PLATE XXVI. *1. Buds and flowers eaten by larvae. 2. Eggs just under the cuticle of under surface of the leaf. 3. A portion of the leaf enlarged. 4. Blotches on upper surface of leaf caused by eggs.* From a photograph. (Original.)

PLATE XXVII. *1 and 2. Larvae natural size and enlarged. 3. Shows arrangement and nature of spines. 4 and 5. Cocoons natural size and enlarged.* From photograph and drawing. (Original.)

PLATE XXVIII. *1. Male. 2. Female. The saw-like ovipositor is shown at the right of Fig. 2.* (Original.)

PLATE XXIX. *Experimental plats. The sprayed bushes are shown on the left, unsprayed on the right.*

PLATE XXX. *1 and 2. Eggs of grapevine flea-beetle* (Haltica chalybea) *natural size and enlarged.* (Original.) *3.*— a. *Beetle.* b. *Larva.* c. *Larvae and beetles on foliage.* d. *Injury to buds.* e. *Beetle killed by fungus. Figures* a *and* b *much enlarged, rest natural size.* From U. S. Dept. Agr. Yearbook 1895, p. 395; by C. L. Marlatt.

V. TWO DESTRUCTIVE ORCHARD INSECTS.*

V. H. Lowe.

SUMMARY.

The apple tree tent caterpillar has been unusually abundant throughout the State during the past season. Although it feeds readily upon a variety of fruit and other trees it has been especially injurious to the apple.

The eggs are laid in July in conspicuous brown rings or masses about the smaller twigs. The caterpillars are formed in the eggs by fall, but do not leave them until early the following spring. They feed upon the leaves. The caterpillars from each egg mass unite in spinning a tent among the smaller branches in which they remain except while feeding. They are full grown in about five or six weeks and spin their cocoons in any convenient place. The adults are brown moths conspicuously marked with two parallel oblique lines of white on the fore wings.

The egg masses may be easily gathered and destroyed during the winter. The caterpillars may also be destroyed while congregated in the nests or by an arsenical spray.

The spraying experiments with Paris green, green arsenite and arsenite of lime indicate that the two last named are equally effective, when properly applied, as a poison for the apple tree tent caterpillar and canker worms. Their principal advantages over Paris green lie in their cheapness and the fact that they will remain suspended in water much longer.

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* Reprint of Bulletin No. 152.

INTRODUCTION.

The two species of insects discussed in this bulletin are among the most common of the apple orchard. Both are found every year throughout the State in varying abundance. They have similar habits in their methods of feeding in that both consume the leaves and will quickly defoliate a tree if left undisturbed. They pass through similar transformations and the adults of both are moths. Of the orchard fruits both insects are usually most destructive to the apple, although other fruit trees are not exempt from their attack.

The apple tree tent caterpillar, although an insect very easy to control, was probably never more abundant throughout the State than during the past season. The unsightly nests of the caterpillars were much too conspicuous along the roadsides of otherwise well-kept farms, while comparatively few uninfested apple orchards could be found. The spring canker worm also, although probably not so evenly distributed over the State, has been very abundant in certain localities. From this is seems evident that these insects should receive more careful consideration than heretofore in order to prevent their still further increase in numbers and the consequent injury to the orchards. Every farmer should be on the watch for them and take prompt measures for getting rid of them when they appear on the trees, whether by the roadside, in the dooryard or in the orchard.

THE APPLE TREE TENT CATERPILLAR.

Clisiocampa americana Harr.

Order LEPIDOPTERA; Family LASIOCAMPIDÆ.

CLASSIFICATION AND NAME.

Classification.— As indicated in the heading of this section the apple tree tent caterpillar belongs to the order LEPIDOPTERA. This order includes the moths and butterflies, among which, especially

in the former group, are found some of the most destructive insects of the orchard. The family Lasiocampidæ, into which this species is further classified, includes according, to Comstock,[1] less than 30 described North American species well distributed throughout the United States. Thus the family may be considered a comparatively small one but, because of the serious injury which its members are capable of doing, of much economic importance. The more common eastern species of this family represent three genera, namely, *Clisiocampa* which includes the tent caterpillars, *Phyllodcrma* and *Tolype* which include the lappet caterpillars, so-called because they have on each side of each segment a small lappet or lobe. From an economic standpoint the genus *Clisiocampa* is the most important.

Scientific name.— The scientific name, *Clisiocampa americana,* was first proposed by Harris[2] in 1852, but only a brief description was then given.

Popular names.— No less than 9 popular names have been applied to this insect by writers on economic entomology as follows: "The American Lackey Moth," "The American Lackey Worm," "American Lackey Caterpillar," "The Apple Tree Caterpillar," "The Apple Web Worm," "The Tent Caterpillar," "The American Tent Caterpillar," "The Orchard Tent Caterpillar" and "The Apple Tree Tent Caterpillar." The last name has been generally adopted by more recent writers.

HISTORY AND PRESENT DISTRIBUTION.

This species is a native of North America. The earliest records which we have of it show that it was a troublesome species to the early settlers of Massachusetts. Fitch[3] states that it did much harm in Massachusetts in 1646 and 1649, so that these years were

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1 Manual for the Study of Insects, p. 360.
2 Harris' Treatise on Insects, p. 289.
3 Noxious Insects of New York. Rpts. 1 and 2, p. 185.

termed by the settlers "caterpillar years." Again in 1658, according to Flint,[4] they were unusually abundant in Massachusetts.

The early writers on economic entomology of the present century also frequently refer to this insect as a serious pest. W. Gaylord,[5] writing in 1843, considered it at that time one of the most important insects of the orchard. In 1855 the caterpillars were again unusually numerous. Fitch states that he had not known them to be as abundant for the previous 25 years.

There appears to be no evidence that the caterpillars were again unusually numerous over a very wide area until 1883. In referring to this outbreak Dr. Lintner[6] states: "There is no record of its ever having appeared before in such enormous numbers over as extended a territory." The year following, according to the same author, the caterpillars were somewhat less abundant and until the past 3 or 4 years they appear to have been on the decrease. During the past 2 years they have again appeared in unusual numbers.

The species is now widely distributed throughout the United States and Canada. It is especially abundant throughout the Eastern and Central States. It also occurs in abundance in the South and is common in the Western States. It is probably safe to say that the insect is found in varying abundance practically wherever apples are grown in North America.

MEANS OF DISTRIBUTION.

According to some of the earlier entomologists, notably Fitch,[7] the apple tree tent caterpillar has been widely distributed on nursery stock by means of the egg masses on the young trees. Fortunately more pains is now taken to produce stock entirely free from insect pests of all kinds so that it is not probable that an insect so conspicuous as this in all its stages of development is

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[4] Agriculture of Mass., 2d Rpt., p. 33; as quoted by Fitch, Rpts., 1 and 2, p. 185.

[5] Trans. N. Y. State Agrl. Soc., 1843, p. 152.

[6] Fifth Report, p. 152.

[7] Noxious Insects of New York, Rpts. 1 and 2, pp. 197–198.

distributed to any appreciable extent in this manner. Locally it is readily disseminated by the female moth which flies with comparative ease even when burdened with eggs.

NATURE OF THE INJURY CAUSED BY THE APPLE-TREE TENT CATERPILLAR.

The nature of the injury caused by this insect is readily apparent. In addition to the unsightly nests which mar the beauty of the tree, the caterpillars devour the foliage, often completely stripping the limbs. Thus the vitality of the tree is greatly impaired, resulting in materially weakening it if the evil is not checked.

FOOD PLANTS.

The caterpillars manifest a decided preference for the wild cherry and hence it is probable that this is their native food plant. Next to the wild cherry the apple seems to be preferred. From time to time, however, they have been found feeding upon apparently new food plants as if extending their bill of fare until now the following may be included in the list: Cherry, apple, plum, peach, rose and other members of the rose family, witch hazel, beech, barberry, various species of oaks, willows and poplars. In addition to some of these Weed[8] reports finding them upon a species of birch.

DESCRIPTIONS AND LIFE HISTORY.

The egg.— The eggs are a dull or dirty gray color. They vary slightly in size and shape. They average about 1.3 mm. long by a little more than half the length at the top and tapering slightly to the base. The upper end is quite uniformly circular and has a dark shadowy spot in the center. There may be a decided dent in the base of the egg when removed from the egg mass and the sides be pressed out of shape. The eggs have been aptly compared

[8] N. H. Coll. Agrl. Expt. Sta. Bul., 38. p. 53.

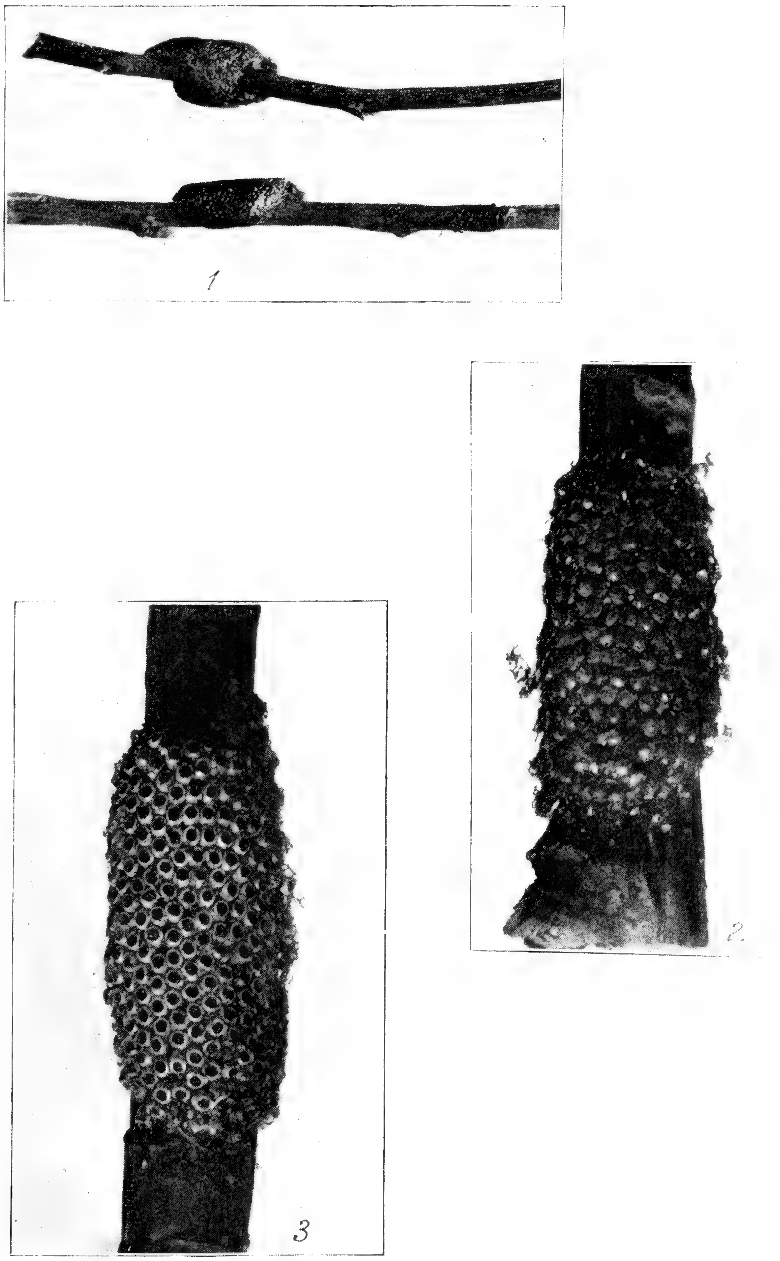


PLATE XXXI.—EGG MASSES; BEFORE (2) AND AFTER (3) HATCHING. (ORIGINAL.)

to minute buckets with the covers on and without handles. The shell is smooth and tough and the inside has a bluish tinge.

The eggs are usually laid before the middle of July. It is not unusual to find them about Geneva before the tenth. Each female deposits all of her eggs in one mass on any of the smaller twigs, forming a thimble which may or may not reach clear around the twig. The eggs are placed on end close together, cemented and covered to the depth of about one-sixteenth of an inch by a thin frothy glue of a light brown color. This glue soon hardens into a tough but somewhat brittle covering, which has a brilliant surface. The whole mass is somewhat oval, partly due to the fact that the eggs on the margins of the mass are placed in an inclined position.

The number of eggs in a single mass or thimble varies. The number is usually placed at from 150 to 250. A number of egg masses on peach and apple twigs examined by the writer contained on the average about 223 eggs each. At Plate XXXI, Fig. 1, two egg masses are shown natural size. Fig. 2 shows one of the masses enlarged with the frothy covering removed to show arrangement of the eggs. Fig. 3 shows an old egg mass enlarged from which the caterpillars have escaped.

Period of incubation.— As above stated the eggs are usually laid before the middle of July. The larvæ are fully formed within the eggs before or during the fall. The exact time was not observed but eggs examined early in November contained fully developed larvæ. The larvæ come forth early in the spring. In 1897 and again in 1898 eggs under the writer's observation hatched about the middle of April. The period of incubation then, counting the time that the developed larvæ remain in the egg, is between 8 and 9 months.

The larva.— Last year in orchards about Geneva the young larvæ were hatching April 18. They were quite common and building nests 5 days later. The newly hatched larvæ measured 1.7 mm. in length. They are dull black in color and are sparsely

covered with long gray hairs. When first hatched they swarm upon the egg mass. If other food is not plenty they will eat the glue that covers the eggs. About 100 caterpillars hatched in a cage in the laboratory subsisted for 6 days upon no other food than the frothy glue that protected the eggs from which they hatched.

The caterpillars spread a thread of silk wherever they go. The young when disturbed will drop suddenly, suspending themselves by means of a silken thread in much the same manner as the canker worm. This habit of the young is not common with the mature caterpillars.

Soon after hatching, if food is plenty, they select a place to build a nest. Usually the nest is built by only one colony of caterpillars, but if two masses of eggs are placed near together the caterpillars from both masses may unite in building a single nest.

From observations on several nests it appears that if the weather is favorable and food plenty the caterpillars are ready to begin building the nest within about two days after hatching. The place selected is usually the angle formed by some branching limb near the egg mass. The larvæ are social, living together within the nest and feeding together upon the leaves.

The number of molts.— Some of the caterpillars kept in breeding cages molted 5 and a few 6 times. The first 2 molts take place within 7 or 8 days after hatching and the third about a week from the second. The fourth and fifth take place within the next 2 or 3 weeks and the sixth, when it occurs, 4 or 5 days later. The color markings begin to show prominently after the first molt.

Growth and feeding habits.— Most of the caterpillars under observations were fully grown and ready to pupate about 6 weeks after hatching. They were extremely voracious especially when about two-thirds grown. It has been estimated that when at this age a single caterpillar will eat two fair-sized apple leaves in a single day. A nest of 200 caterpillars all eating at this

PLATE XXXII.—TENT OF APPLE-TREE TENT-CATERPILLAR WITH CATERPILLARS.
(ORIGINAL.)

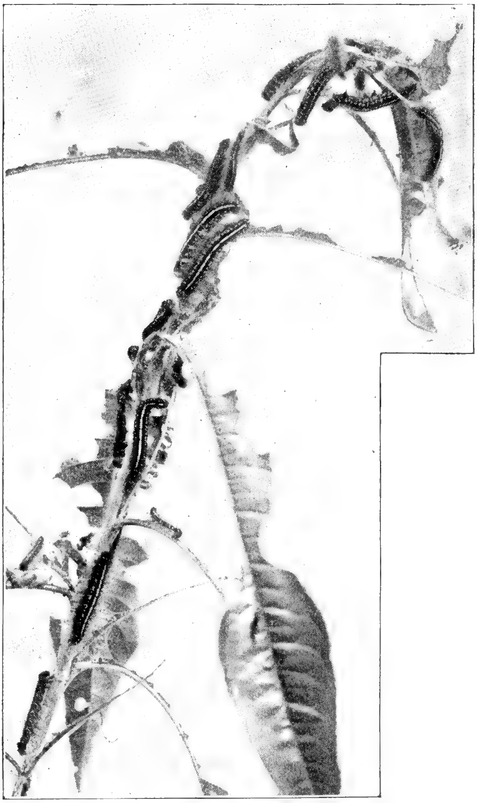


Fig. 5.—Caterpillars Upon a Peach Twig, About to Begin Feeding.
(Original.)

rate would consume 400 leaves per day. While no very extensive data bearing on this point were obtained from the caterpillars kept in the insectary, it was observed that in one instance a single caterpillar, nearly full grown, devoured one large sized peach leaf during the day, and several instances were noted where an entire apple leaf, not exceeding 2 inches in length, was consumed during the forenoon.

During favorable weather the caterpillars feed at quite regular intervals. Their favorite time is during the middle of the day. When not feeding they stay in or upon the nest and also retreat to it during cold or stormy weather. In going to and from the nest the caterpillars follow the same path, usually preferring the upper side of the limb and always spinning a thread of silk as they pass along. Thus the branches in the vicinity of the nest over which the caterpillars have frequently passed become covered with silk on the upper surface.

Plate XXXII is from a photograph of a nest full of caterpillars with some on the outside. The photograph was taken about 4 o'clock in the afternoon, just before a severe thunderstorm. Half an hour before this the caterpillars were scattered about the neighboring branches. As a rule they seem to prefer not to wander far from the nest, but as long as food is plenty will feed near by. They also seem to prefer to go toward the top of the tree for their food rather than toward lower branches. In going to and from the nest they follow each other closely; sometimes in single file or two or more together. Figure 5 is from a photograph of some caterpillars on a peach twig about to begin feeding on the leaves.

The full grown caterpillars measure nearly two inches in length. The body is sparsely covered with long yellowish hairs. The general color is black. A prominent white stripe extends the entire length of the back. Numerous shorter irregular lines extend along the sides. A row of oval, pale blue spots, one upon the middle of each segment, extends along the sides. The under side of

the body is black. Plate XXXIII, Figs. 1 and 2 are from photographs of the caterpillars, natural size.

The following descriptions of the larva in its various stages of growth were written by Dr. Asa Fitch,[9] the first State Entomologist of New York. No more complete descriptions are necessary and hence they are appended here:

Larva.— The larvæ, when they first come from the eggs, are 0.08 in. long, slightly tapering, of a black color, the under side and legs pallid, and they are slightly clothed with soft gray hairs. After they commence feeding, they show a pale ring at each of the joints, and a faint pale stripe lengthwise along the back upon each side of its middle, and another low down upon each side. The head is deep black and some deep black dots may be discovered upon the body, from which the hairs arise. When they are a few days old and before the first moulting, they have increased to double their original size, and show some ash-gray or whitish lines more or less distinctly, running lengthwise upon the back and sides.

After the first molt it is 0.20 in. in length, of a dark gray color, with two ashy-white lines along the back, and two along each side, the space above the upper lateral line having a large blackish spot on each segment. The hind edges of the segments and the under side of the body is also pale ash-gray, the head velvety black, and the body is clothed with numerous ash-gray hairs of different lengths.

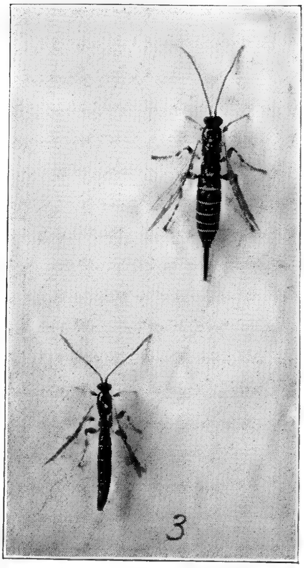
After the second molt it is half an inch in length, and nearly cylindric, the head being scarcely any broader than the body. It is now black and hairy, the neck with numerous long hairs directed forward and overhanging the head, which is velvety black. A broad dull stripe extends along the back and a narrower wavy brighter blue one along each side, and several short curved blue lines between them.

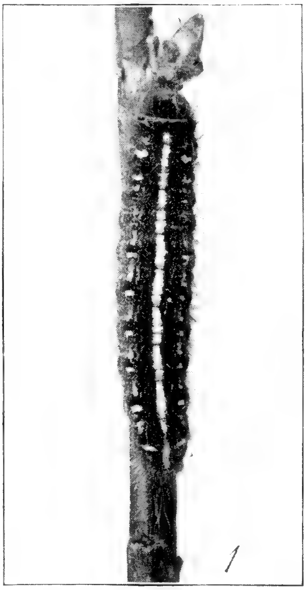
After the third molt it has reached three-fourths of an inch in length, with yellowish white hairs, and stripes, etc., much the same as before.

After the fourth molt it is about an inch long, of a velvety black color, with numerous yellowish or fox-colored hairs, with a white stripe down the back, and numerous short, crinkled white lines on the back and sides; a large black spot on each side of each segment, in the hind part of which spot is a transverse oval pale blue spot, having an impressed line across it; a second pale blue spot in the crinkled white lines below the black spot.

The full-grown caterpillar is about two inches long and over a quarter of an inch thick, cylindrical, sixteen-footed and thinly clothed with fine, soft, yellowish or fox-colored hairs of different lengths, the longest ones measuring a quarter of an inch. These hairs are rather more numerous upon the back, where they project obliquely forwards, shielding in some measure the head, which is black and furnished with shortish black hairs. The body is of a deep black color. The white stripe extends along

[9] Second Rpt., 1856, pp. 193, 194.





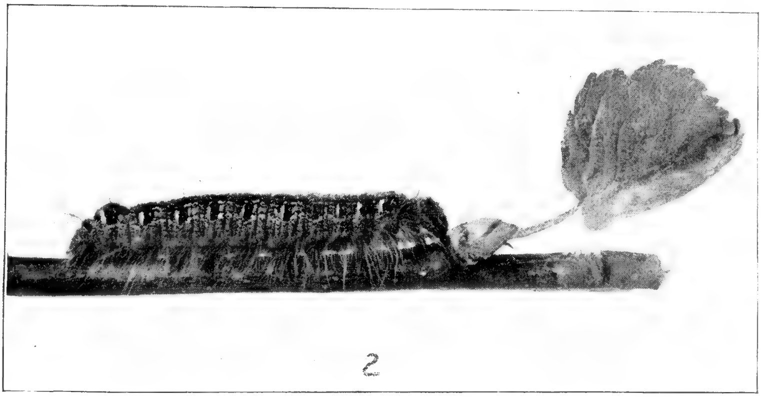


PLATE XXXIII.—FIGS. 1 AND 2. DORSAL AND LATERAL VIEWS OF AN APPLE-TREE TENT-CATERPILLAR; 3. *Pimpla conquisitor*, MALE AND FEMALE. ALL NATURAL SIZE. (ORIGINAL.)

the back its entire length, and commencing upon the second or the base of the first segment back of the head. In this stripe are numerous minute black dots. On each side of it are a number of short, crinkled, irregular longitudinal lines, of a yellow color, which become paler down upon the sides. Above the lowermost series of these lines is a row of transverse oval pale blue spots, one upon the middle of each segment. On the anterior side of each of these spots is a broader deep velvety black spot, as it appears to the naked eye, forward of which is a rather faint pale blue oblong spot or short stripe, reaching to the anterior margin of the segment. Lower down, the sides are mottled with the same tint of pale blue coloring, interspersed with short, crinkled pale yellow or whitish lines. The under sides of the body and legs are black, the soles of the prolegs white. The neck or anterior edge of the segment next to the head is also white, with two small, somewhat square, yellow spots above.

The tent.— The tent or nest (Plate XXXII) is built in any convenient angle of the limbs. It is composed of successive sheets of silk stretched across from limb to limb and is enlarged from time to time to suit the needs of the growing occupants. Access is had to the interior by irregular openings in the silk. The silk is coarse and sufficiently strong to resist even severe wind and rain storms. As previously stated only the caterpillars from a single egg-cluster usually build and occupy the same nest. There are undoubtedly exceptions to this rule. The writer observed a case last season where two colonies of caterpillars, the egg-clusters from which they hatched being near together on the same twig, built and occupied one nest together.

Pupation.— Toward the latter part of May the caterpillars are ready to pupate. At this time they may be found crawling down the trunks of the trees or wandering about on the ground in search of places to spin their cocoons. The cocoons average about an inch in length and are oval in shape. They are composed of strands of course white silk woven loosely and intermixed with a saffron yellow powder. Some of the hair from the caterpillar's body may sometimes be found interwoven with the silk. Some of the cocoons are thin and flimsy, while others are more closely woven.

The cocoons are placed in any convenient location, sometimes singly or together in numbers. They may be found upon the

trunks of the trees partially protected by the loose bark, in the grass under the trees, in protected places in and about the fences and in the angles about the eaves and window casings and along the sides of outbuildings. Not unfrequently the outbuildings seem to be the favorite place for pupation. In several badly infested orchards under observation last year it was found that when ready to pupate most of the caterpillars deserted the orchards and spun their cocoons upon nearby buildings. The cocoons spun in the grass were usually in a nearly upright position, and were supported by numerous threads of silk leading to neighboring blades of grass.

Figure 6 is from a photograph of a bunch of cocoons taken from a building upon which the caterpillars congregated in large numbers to pupate.

The length of time required for the pupa stage varies. Fitch cites instances where the pupa stage lasted from 14 to 26 days, and from observations upon 9 caterpillars kept in confinement he found the average time required about 3 weeks. About 100 caterpillars under the writer's observation last year pupated during the first week in June, and those that matured emerged between June 27 and July 1. A few did not emerge until July 8.

The adults.— The adults are reddish-brown moths of the size shown in Plate XXXIV, Figs 1 to 4. The marks by which they are most readily distinguished are two nearly parallel white lines which extend obliquely across the fore wings.

The following detailed description is from one of Dr. Fitch's[10] reports:

> The winged moths are of a dull reddish or fox color, different individuals varying in the depth of their coloring, the females being often paler, approaching to grayish, and the males often darker, sometimes brown, with scarcely any tinge of red. The mark by which this species is most readily distinguished is two straight, white stripes which extend obliquely across the fore wings, parallel to each other, and to the hind margin, dividing the wing into three nearly equal portions. The anterior stripe is often slightly broader than the posterior one, especially towards

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10 Second Rpt., pp. 196, 197.

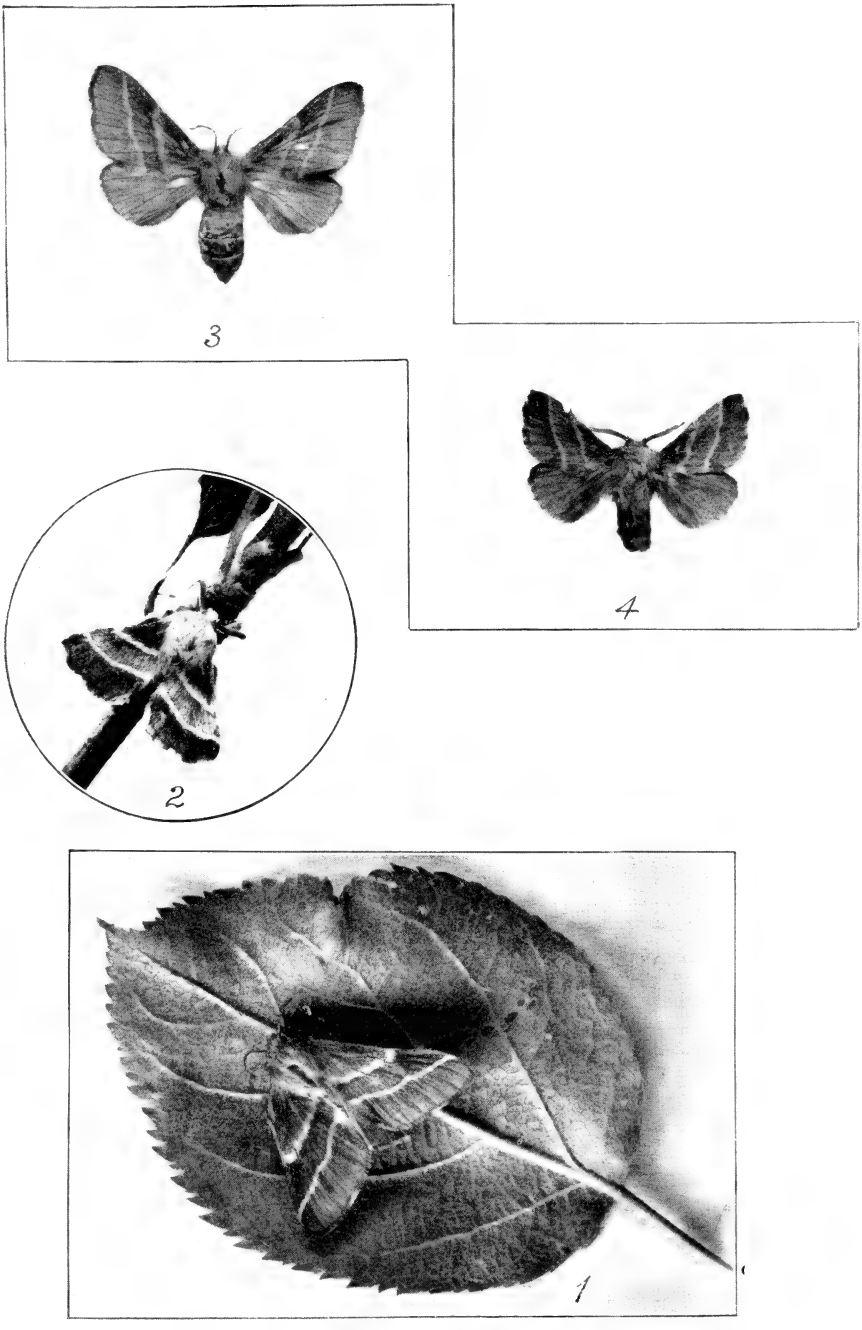

Plate XXXIV.—Male (2 and 4) and Female (1 and 3) Moths. Natural Size. (Original.)

Fig. 6.—Cocoons of the Apple-Tree Tent-Caterpillar.
Natural Size. (Original.)

the outer margin of the wing. In some females these stripes are placed nearer to each other; and though commonly parallel, in some instances from the middle of the wing to the outer margin, or even through their entire length, they diverge from each other. In the males they are less variable, but the space between them in this sex is frequently pale gray and there are also numerous gray hairs on the basal portion, and a few toward the apical margin also. The hind wings are of the same color as the anterior ones, but without any pale marks. On their under sides the wings are the same color as above, and commonly a white band extends across both pairs near their middle, that on the fore wings being straight and widened at the outer end, that on the hind wings broader and curved. The fringe on the fore wings has a white alternation near the outer angle and another broader one on the middle; along the inner angle and on the hind wings it is white, slightly varied in places with dull reddish. These colors of the fringe are much more distinct in the darker colored varieties of the male. The hairs with which the thorax is densely coated are often grayish. The stalk on the antenna is dull white and its branches are dark, dusky red, sometimes with a whitish line on their outer side. The feet are white or yellowish white, particularly in the males. The wings, when spread, measure from 1.20 to 1.30 inches in the males, and in the females 1.40 to 2 inches.

During the first week or ten days of July most of these adults have emerged and hence it is during this time that they are most numerous. They are not usually seen, however, as their habits are nocturnal. The eggs are deposited very soon after the moths take flight. Plate XXXIV, Figs 1 and 2, show the moths with wings at rest, Figs. 3 and 4 with wings spread, all natural size.

SUMMARY OF LIFE HISTORY.

There is but one brood annually. The eggs are laid early in July. The caterpillars are fully formed in the eggs by early November. They leave the eggs about the middle of the following April. Soon after hatching the caterpillars from each mass of eggs begin to build a silken tent, usually in the forks of some of the smaller limbs, in which they remain except while feeding. They feed upon the leaves and are full grown and ready to pupate late in May or early in June. The moths emerge during June or early in July. The time for these changes varies according to the season.

NATURAL CHECKS.

Insects that live so much exposed while in the caterpillar stage as does the apple tree tent caterpillar fall an easy prey to many natural enemies which greatly lessen their numbers. The natural checks upon this insect may be classified under 5 heads, as follows: Climatic changes, birds, predaceous insects, parasitic insects and parasitic diseases.

Climatic changes.— The caterpillars are most susceptible to these changes just after hatching or before they have become well established in the nest. A cold wind and rain storm at this time may kill great numbers of them.

Birds.— Birds form one of the most important natural checks to many species of noxious insects. But unfortunately many of the birds which depend largely upon insects for food are being rapidly killed off, thus depriving the farmer of some of his most valuable allies in his conflict with his numerous insect enemies.

The following birds are known to feed upon the apple tree tent caterpillar: The yellow-billed and the black-billed cuckoos, black-capped chicadee, Baltimore oriole, red-eyed vireo and wren. Nearly all of these have been observed in and about Geneva. Of these the yellow-billed and the black-billed cuckoos and black-capped chickadee are probably the most important. The former feeds readily upon the caterpillars, while the latter feeds upon the eggs and young caterpillars. According to Forbush, as quoted by Weed,[11] the crow, chipping sparrow and yellow warbler also feed upon the caterpillars. It is probable that the warbling vireo may also be added to this list as Mr. W. P. Wheeler states that he recently saw one enter a nest of the caterpillars, remain for several minutes and give other evidence of feeding upon the young caterpillars. Further observation will undoubtedly add many species to this list. The writer will be especially glad of any information relating to the birds which prey upon noxious insects.

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[11] N. H. Coll. Agrl. Expt. Sta. Bul. 38, p. 55.

Predaceous insects.— Several species of predaceous insects feed upon the caterpillars, usually attacking them when crawling down the trunk of the tree or upon the ground in search of a suitable place to spin their cocoons. Among the most important in this State are the large ground beetles, *Calosoma scrutator* Fab. and *Calosoma calidum* Fab., and the spiny soldier bug, *Podisus spinosus* Dallas. Although these insects are very voracious and feed readily upon the caterpillars they are not usually sufficiently abundant to materially lessen their numbers.

Parasitic insects.— Of much more importance than the predaceous insects as a check to the apple-tree tent caterpillar are the parasitic insects which prey upon it. Both the eggs and caterpillars are attacked, as at least one species, *Telenomus clisiocampae* Riley,[12] is known to prey upon the eggs.

Parasites attacking the caterpillars usually occur in sufficient numbers to be of some real value in checking the increase of the species. These useful little insects were evidently very abundant last summer. Out of 559 cocoons collected by the writer and brought into the laboratory, only about 20 per cent produced moths leaving 80 per cent victims of the parasites. The following species were bred from the cocoons, *Pimpla conquisitor* Say (Plate XXXIII, Fig. 3, male and female natural size)[13] *Pimpla conquisitor* var., *Pimpla pedalis* Cr.,[14] *Theronia fulvescens* Cr.,[14] *Spilocryptus* (*Cryptus*) *extrematis* Cr., *Mesotenus* sp.,[14] *Dibrachys baucheanus* Ratz., was also reared in small numbers but this is a secondary parasite. In addition to the above *Pimpla annulipes* Brullé, *Theronia melanocephala* Brullé, and according to Felt,[15] *Apanteles congregatus* var. *rufocoxalis* Riley and the parasitic fly, *Frontina frenchii* Williston, are known to prey upon this insect.

Diseases.— At least one well-marked disease sometimes reduces the number of these tent caterpillars. It is bacterial in its nature

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12 U. S. Natl. Museum Bul., 15, p. 450.
13 Determined by Miss A. M. Beach.
14 Determined by Mr. W. H. Ashmead through courtesy of Dr. L. O. Howard.
15 N. Y. State Mus. Bul. 23, vol. 5, p. 183.

and is most prevalent during warm, moist weather. The affected caterpillars at first become sluggish in their movements, finally cease to eat and die soon after.

When the disease is prevalent it is not unusual to find large numbers of the dead and dying caterpillars congregated in the nests.

Value of natural checks.—While it is evident that these natural agencies do much toward checking the increase of this and many other species of noxious insects, so much dependence should not be put upon them as to lead to delay in promptly applying preventive and remedial measures. But such friends as the birds should be protected and encouraged whenever possible. If let alone, or better, if encouraged to visit the orchard, they will do much toward ridding it of many of the noxious insects which annually exact a heavy tax from the farmer.

PREVENTIVE MEASURES.

Probably the most important preventive measures consists of keeping the roadsides and farms free from wild cherry trees and neglected apple trees and brush. The insect prefers the wild cherry, and where these trees are allowed to grow the usual result is that neighboring orchards soon become infested.

REMEDIAL MEASURES.

Collecting the eggs.— Very much can be done toward checking this insect by collecting the egg masses during the winter. The exact time and methods for doing this work can best be decided by the individual. A very good time is while pruning the trees. If a sharp lookout is kept it will not be difficult to detect them. Whenever found they should be burned or otherwise destroyed. It is not safe to leave them on the ground.

In some places encouraging the destruction of the egg masses by offering a reasonable bounty has been tried with good results. As an illustration, the following is quoted from a paper by Dr. C.

M. Weed:[16] "In the village of Newfields, N. H., the improvement society offered the school children 10 cents a hundred for all the egg masses, or caterpillar belts, as they are locally called, that they would bring in. Many of the children worked faithfully, and when in February I was called to point the moral of the process I found that 8,250 egg masses had been obtained." Allowing 150 eggs to each egg mass, there were 1,237,500 eggs destroyed for an expenditure of $8.25. Taking into consideration the injury which the caterpillars from so many eggs are capable of doing it will be seen that the investment was a mere trifle compared with the good accomplished.

Destroying the caterpillars.— The methods of destroying the caterpillars may be grouped under two heads, as follows: Spraying the infested trees with an arsenical poison and destroying the caterpillars in any convenient way while in the nests.

Spraying.— Like other caterpillars which devour the leaves this species is susceptible to arsenical poison. Orchards that are systematically sprayed with pure Paris green or other arsenical seldom suffer serious injury from the attacks of this insect.

Experiments.— In connection with the spraying experiments against the canker worm as shown on page 385 of this Report, the effect of the poison was observed on the caterpillars from a number of nests. The experiments were conducted in an apple orchard at Rushville, N. Y., owned by Mr. O. L. Jackson.

Objects of the experiments.—Many requests have come to us for information concerning the effects of arsenical poisons upon the tent caterpillar. While it is usually more practical to destroy the caterpillars in the nests it is sometimes desirable to know whether spraying with arsenical poisons will check them. It was the object of these experiments to throw some light upon the subject.

Experiments in 1897. Green arsenite.— The green arsenite was used at the rate of 1 pound to 150 gallons of lime water.

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16 Notes on The Tent Caterpillar, U. S. Dept. Agr., Div. Ent., Bul., 17 n. ser., pp. 76–78.

About 300 caterpillars included in 3 nests were used in these experiments. The first application was made May 22, the second 4 days later and the third 7 days from the time of the second application. At the time of the first application the caterpillars were less than half grown.

Paris green.— Similar experiments were made with Paris green. It was applied in the same proportion and at the same time as the green arsenite.

Results.— Four days after the first application nearly all of the caterpillars were sluggish. Within 3 days after the second application only a few live worms could be found. The third application was hardly needed. Where the Paris green was evenly applied there was no apparent difference between its effects and that of the green arsenite.

Experiments in 1898. *Green arsenite.*— About 200 worms, from 2 nests, were used and the green arsenite applied twice in May at intervals of ten days. The green arsenite was mixed with lime water in the same proportion as in 1897. No Paris green was used.

Arsenite of lime.— (For formula see page 388 of this report.) Similar experiments were conducted with arsenite of lime, the applications being made at the same time.

Results.— The effects were practically the same in both instances as with the poisons used the year previous.

Conclusions.— The above indicates that the 3 arsenicals used may be depended upon to kill the caterpillars if applied early enough. The first application should be made before the caterpillars are half grown.

Destroying the caterpillars in the nests.— This is done in a variety of ways. Any way that is thorough and convenient and does not result in injury to the tree will answer. It is only necessary to be prompt and thorough. A common practice is to pull out the nest with the gloved hands and destroy the caterpillars. Others practice burning the nests with a torch or pouring kerosene upon them.

TWO OTHER TENT CATERPILLARS.

As previously stated on page 365 there are two other species of tent caterpillars common in the east; these are the forest tent caterpillar, *Clisiocampa disstria* Hubn., and the fall web worm, *Hyphantria cunea* Dr.

THE FOREST-TENT CATERPILLAR

This species is closely related to the apple tree tent caterpillar and is undoubtedly often confounded with it. As its name indicates, however, it feeds principally upon the leaves of forest trees of which the maple seems to be its favorite. But it also feeds readily upon various species of fruit trees, and was quite common in the apple orchards last year, often feeding in company with the apple tree tent caterpillar.

The habits of the two species are quite similar. The egg masses of the forest tent caterpillar are placed in a similar manner, but can be readily distinguished, as they are of nearly uniform diameter and are cut off more abruptly at the ends. The young caterpillars appear at about the same time in the spring and at first resemble their near relatives quite closely. But they soon begin to show a difference in markings, and when full grown can be readily distinguished by the dorsal row of white diamond shaped spots in place of the unbroken white line characteristic of the other species.

The web of this species is delicate and inconspicuous. In many cases there appears to be no web at all. The adults are easily distinguished by the oblique lines on the fore wings which are dark in color instead of light, as with the foregoing species. The space between the lines is also usually darker.

THE FALL WEB WORM.

The webs of this species are frequently conspicuous in the fall upon forest and fruit trees. Of the fruit trees it seems to prefer the apple. The eggs are placed upon the leaves and the cater-

pillars spin a rather delicate web over the leaves upon which they are feeding. As the caterpillars live in colonies these webs sometimes become quite large and unsightly. The insect passes the winter in the pupa stage, the moths emerging in the spring. The adults are white or slightly flecked with color.

While this species seldom becomes so abundant in the orchard as the apple tree tent caterpillar, it not infrequently does serious injury when not promptly checked.

BIOGRAPHICAL LIST.

The following list is intended to contain only the more important papers relating to the apple tree tent caterpillar. A large number of compiled and popular articles are purposely omitted.

1826. Harris, T. W. N. Eng. Farmer, 4: 354. Treats of orchard tent-caterpillars.

1830. Harris, T. W. N. Eng. Farmer, 9: 1, 2.

1843. Gaylord, W. Trans. N. Y. State Agrl. Soc., 3: 127–174. Considered one of the most important of orchard insects; life history briefly given. Remedies destroying nests and caterpillars with lye, whitewash, poles with bushes or cobs attached, whale oil, soap suds, burning off the nests with gunpowder, crushing the worms while in the nest. The last-named method especially recommended.

1852. Harris, T. W. Harris' Treatise on Insects, pp. 285–291. Life history and habits, with remedial measures. Proposes specific name.

1856. Fitch, Asa. Noxious Insects of N. Y. Repts. 1 and 2, pp. 181–197. Classification and history, detailed description of various stages, full notes on life history, together with remedies.

1860. Fitch, Asa. Trans. N. Y. State Agrl. Soc., 19: 595. Briefly mentioned in a popular address.

1865. Packard, A. S. Prac. Ent. 1: 14–15. Notes on an egg parasite of C. americana.

1866. Walsh, B. D. Prac. Ent., 1: 46. Food plants of C. americana.

Ibid, p. 78. Hemitcles sp., Mesiagastes sp., bred from cocoons attached to eggs of C. americana.

1867. Walsh, B. D. Prac. Ent., 2: 72. Egg mass described and food plants of C. americana, and C. sylvatica given.

Ibid, p. 117, mentions scarcity of C. americana in 1867 and attributes it to egg parasites.

Ibid, p. 119, records finding eggs of C. americana on sugar maple.

Ibid, p. 121, records injury to pear tree by C. americana.

1869. Walsh and Riley. Amer. Ent., 1: 208. Describes early stages and adult and discusses remedial measures.

1869. Ibid, 2: 39. Life history, habits, description and food plants of C. americana.

1870. Riley, C. V. Amer. Ent., 2: p. 245. Records ravages of C. sylvatica (disstria) and C. americana.

Ibid. Third Missouri Report, pp. 117–120. Gives life history, with descriptions of various stages and remedial measures.

1871. Glover, T. Ann. Rept. U. S. Com. Agr., 1871, pp. 65–91. Records unusual destructiveness in certain localities in 1870; observations upon the eggs and life history. Remedy, destroying egg nests.

Bethune, C. J. S. Report Fruit Growers' Assoc. Ent., 1870–1871, pp. 68–93. Characters, habits, injury, means against C. americana.

1872. Saunders, W. Can. Ent., 4: 133–136. Life history and habits.

1873. Bessey, C. E. Ann. Rept. Iowa State Agrl. Soc., 1873, pp. 230–232. Life history and habits, with description of various stages given. Remedies, collecting the eggs and destroying the nests, suggests planting wild cherry trees in the orchard as traps.

1874. Cook, A. J. Twelfth Annual Rept. Sec. Mich. Bd. Agr., 1873–1874, pp. 106–115. Account of life history. Remedies, destroying young larvæ by hand, crushing in the nests, shooting with gunpowder, burning, application of strong soapsuds; refer to Fitch's suggestion to plant wild cherry trees in orchard for traps.

1875. Saunders, W. Ann. Rept. Ont. Soc. Ent., 1875, pp. 29–31. Habits and ravages of C. americana.

1876. Fernald, C. H. Ann. Rept. Sec. Maine State Pom. Soc., 1875–1876, p. 17. Brief notes on life history.

1877. Gott, B. Ann. Rept. Ent. Soc., Ont., 1877, pp. 41–42. Referred to as American lackey-worm. Brief notes on life history and methods of combating.

Kridelbaugh, S. H. Ann. Rept. Iowa State Hort. Soc. Brief account of ravages in Iowa and life history.

Packard, A. S. Report on the Rocky Mountain locusts and other insects, pp. 793–794. Brief notes on life history and remedies.

1878. Saunders, W. Can. Ent., 10: 21–23. Observations on the eggs of Clisiocampa americana, C. disstria; and eggs contrasted.

1879. Osborn, H. Trans. Iowa State Hort. Soc., 1879, vol. XIII, pp. 368–402. Brief notes on C. americana.

1881. Lintner, J. A. Cult. and Country Gent., 46: 455. Treats briefly of habits and ravages of "the orchard tent caterpillar."

1887. Fletcher, J. Annual Rept. of Entomologist and Botanist of Canada, p. 29. Brief reference; unusually abundant throughout Canada the past season.

1888. Perkins, G. H. Vt. State Agrl. Exp. Sta. Bul. 11, pp. 4–7. Notes on life history; increasing in numbers in Vermont during past few years.

Bethune, C. J. S. Nineteenth Ann. Rept. Ent. Soc. Ont., pp. 71–73. Popular account of life history, principal remedy destroying caterpillars in their tents.

Harvey, F. L. Ann. Rept. Maine Agrl. Exp. Sta., pp. 159–164. Life history and descriptions of different stages and parasitic insects, remedies destroying eggs and nests.

1888. MacMillan, C. Nebr. Agrl. Exp. Sta. Bul. 2, pp. 59–63. Life history and descriptions of different stages, remedies gathering egg clusters in winter, destroying caterpillars in their tents, gathering cocoons and trapping moths in lantern traps. Considers planting wild cherry tree in orchard (as first recommended by Fitch) desirable.

Atkinson, G. F. First Ann. Rept. S. C. Agrl. Exp. Sta., p. 31. Brief account of life history and remedies.

Lintner, J. A. Country Gent., July, 1888, p. 11. Notes abundance in this State.

1889. Comstock, J. H. Cornell Agrl. Exp. Sta. Bul. 15, pp. 199–202. Life history, with brief descriptions of different stages, remedies destroying nests and early spraying with Paris green. Illustrated.

1890. Bruner, L. Nebr. Agrl. Exp. Sta. Bul. 14, pp. 24–32. Life history, detailed descriptions of eggs, larvæ and adults, food plants, natural enemies and remedies. Illustrated.

1891. Weed, C. M. N. H. Agrl. Exp. Sta., Third and Fourth Ann. Repts., Part II, pp. 255–257. Brief account of life history, remedies destroying nests and spraying with Paris green.

Fernald, C. H. Hatch Agrl. Exp. Sta., Bul. 12, pp. 22–24. Brief account of life history, remedy Paris green. Illustrated.

Townsend, C. H. T. N. M. Agrl. Exp. Sta., Bul. 3. Brief account of life history, with remedies. Illustrated.

Bruner, L. Rept. Neb. State Hort. Soc., for 1891, pp. 195–266.

McCarthy, G. N. C. Agrl. Exp. Sta., Bul. 92, p. 92. Brief popular account. Illustrated.

Weed, C. M. Ann. Rept. Columbus Hort. Soc., p. 166. Illustrated.

1892. Garman, H. Ky. Agrl. Exp. Sta., Bul. 40, pp. 36–39. Brief account of life history. Widespread and destructive pest in Kentucky.

Lintner, J. A. Country Gent., 23 June, 1892, p. 492.

1893. Fernald, C. H. Hatch Agrl. Exp. Sta., Bul. 20. Brief account of life history, remedies. Illustrated.

Weed, C. M. Ann. Rept. N. H. Agrl. Exp. Sta., 1893, pp. 170–172. Brief descriptions and life history.

Chambers. Tenn. Agrl. Exp. Sta., Bul. No. 1, vol. IV, pp. 13–14. Life history, habits, natural enemies food plants and remedies. Illustrated.

Osborn, H. Trans. Iowa State Hort. Soc. for 1892.

Slingerland, M. V. Can. Ent. 25: 81. Tabular statement of C. americana.

Treat, M. Journal N. Y. Ent. Soc., 1893, pp. 16–20.

Webster, F. M. Ann. Rept. Ohio State Hort. Soc., 1893, pp. 63–70.

1894. Jack, J. G. Trans. Mass. Hort. Soc., 1894, pp. 133–150.

1895. Slingerland, M. V. R. N. Y., 11 May, 1895, p. 329.

1896. Lintner, J. A. Country Gent., 22 July, 1896, p. 571.

Weed, C. M. N. H. Agrl. Exp. Sta., Bul. 38. Life history and descriptions, notes on food plants, natural enemies and remedies. Illustrated.

SPRAYING EXPERIMENTS AGAINST THE SPRING CANKER WORM.

There are two principal methods of combating this insect in general use. The first is directed against the insect in the adult stage and consists of placing mechanical obstructions or traps about the trunks of the trees to prevent the females, which are wingless, from ascending the tree to deposit their eggs upon the twigs. The second is directed against the larvæ and consists of spraying with an arsenical poison. Although good results have been obtained by the former method it has been pretty clearly demonstrated that it cannot be depended upon to entirely rid an orchard of this pest. Spraying is, therefore, of much importance as the other principal method of checking the insect.

EXPERIMENTS.

Objects of the experiments.— The principal objects of the experiments were to compare green arsenite and arsenite of lime with Paris green as poisons for the canker worm, and incidentally to again demonstrate that pure Paris green itself, properly handled, can be depended upon as a remedy. It is important to know definitely whether these newer poisons can be depended upon to act as promptly as Paris green, as they are cheaper (page 388) and can be applied more evenly, and hence, if equally efficacious, are more satisfactory.

These experiments were conducted in the orchard of Mr. O. L. Jackson of Rushville, N. Y., to whom the writer is indebted for much assistance in the work of spraying the trees. The orchard is a large one, thrifty, and consists principally of Baldwin apple trees from 25 to 30 years old.

Experiments in 1897.— About one-third of the orchard was badly infested. Only the worst infested trees were selected for the experiments, which were as follows:

Plat I consisted of about 100 trees. Paris green was applied 3 times at the strength of 1 pound to 150 gallons of lime water. The first application was made as soon as the young caterpillars appeared, which was about May 6. The second application was made a week later and the third about 4 days from that time.

Plat II consisted of 14 trees and was sprayed with green arsenite, 1 pound to 150 gallons of lime water. The first application was made May 18, the second May 22 and the third June 1.

Plat III consisted of 3 badly infested trees and was left untouched as a check. The lime was not measured in any of the experiments, but enough freshly slaked lime was used to make the mixtures slightly milky in appearance.

Results.— No very decided results were noticeable on either plat until after the second application, except in the case of the smaller caterpillars, those about one-fourth of an inch long, which succumbed readily. Four days after the second application but very few live caterpillars could be found. The results were practically the same on the two plats. Probably the third application was hardly necessary. On Plat III the trees were nearly stripped of their foliage by June 1.

Experiments in 1898.— This year the orchard was not as badly infested as in 1897. As in the year previous the worst infested trees were selected and divided into plats.

Plat I, consisting of about 40 trees, had two applications of green arsenite at the same strength as in 1897. The caterpillars did not appear as early as the year previous, and hence the first application was not made until about the middle of May and the second about a week later.

Plat II was sprayed 3 times with arsenite of lime made after the Kedzie formula.[17] The first application was made May 27, the second May 31, and the third June 10. Plat III consisted of 2 trees, which were left unsprayed as a check.

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[17] See note at the foot of page 388.

Results.— The results were practically uniform on the two plats. Decided results were apparent after the second application. The treated trees were practically freed from caterpillars by the 2 applications. The third application only ensured a little more thorough work. As in the previous year the check trees were stripped of their foliage.

DISCUSSIONS OF RESULTS AND THE ARSENICALS USED.

The results indicate that any one of the three insecticides can be depended upon to kill canker worms if properly handled, and that green arsenite and arsenite of lime are equally efficacious with Paris green as poisons for this insect. In these experiments much pains was taken to keep the mixtures well agitated, in order to keep the poison well distributed in the tank and to make the applications thorough. Keeping the mixture well agitated is of especial importance when Paris green is used, as it settles quickly.

As the arsenicals give practically even results and the foliage was not injured in any case, the principal points to be considered are the ease of application and the cost per pound of the poison. These points may be brought out more clearly by a brief discussion of each arsenical.

Paris green.— The retail price of Paris green is usually from 25 to 30 cents per pound. It can be bought in wholesale lots, 50 pounds or more, for about 18 cents per pound. The principal difficulty in using Paris green lies in the fact that it settles so quickly to the bottom of the tank and is so heavy that it is difficult to keep it evenly distributed throughout the tank while spraying. The usual result is that most of the poison is pumped out before the water is half gone. Thus the poison is applied very unevenly.

Green arsenite.— This arsenical has been previously discussed.[18] It costs, retail, 15 cents per pound and can be obtained cheaper in wholesale lots. It is manufactured by the Adler Color and Chemi-

[18] Page 340 of this Report.

cal Works, New York city. In addition to its cheaper price, it has the advantage of being much more finely divided than Paris green, and hence stays suspended in water for a considerably longer time. It is, therefore, less difficult to keep well distributed in the tank, thereby ensuring a more even application to the foliage.

Arsenite of lime.[19]— This arsenical will remain suspended in the tank as long as green arsenite, and has the additional advantage of being still cheaper and also of being conveniently made at home, thus ensuring freedom from adulteration.

According to estimates by Dr. Kedzie it costs but 70 cents per 800 gallons when ready to use or but 3-4 of a cent per barrel, while Paris green costs, when used at the rate of 1 pound to 150 gallons of water, about 10 cents per barrel (retail price) and green arsenite 5 cents per barrel.

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19 Directions for making and handling arsenite of lime are given in the *M. A. C. Record,* March 9, 1897, as follows: "Dissolve the arsenic by boiling with carbonate of soda, and thus insure complete solution; which solution can be kept ready to make a spraying solution when wanted. To make material for 800 gallons of spraying mixture boil 2 pounds of white arsenic with 8 pounds of sal soda (crystals of carbonate of soda, 'washing soda,' found in every grocery and drug shop) in 2 gallons of water. Boil these materials in any iron pot not used for other purposes. Boil for 15 minutes or till the arsenic dissolves, leaving only a small muddy sediment. Put this solution into a two-gallon jug and label 'Poison, stock material for spraying mixture.'

"The spraying mixture can be prepared whenever required, and in the quantity needed at the time, by slaking 2 pounds of lime, adding this to 40 gallons of water, and pouring into this a pint of the stock arsenic solution. Mix by stirring thoroughly, and the spraying mixture is ready for use. The arsenic in this mixture is equivalent to 4 ounces of Paris green."

Another method of preparing a white arsenic and lime mixture is given by L. R. Taft in Mich. State Agr. Coll. Expt. Stat. Bul., 155, p. 294, as follows:

White arsenic	1 pound.
Lime.	10 pounds.
Water	400 gallons.

In preparing the lime and arsenic mixture, add 2 pounds of lime and 1 pound of white arsenic, to 2 gallons of hot water, and boil for at least 30 minutes. This should be added to 400 gallons of water, and 8 pounds of lime additional used. Care should be taken to have the lime freshly slaked.

REPORT OF THE ENTOMOLOGISTS.

PART II.

I. A SPRAYING MIXTURE FOR CAULIFLOWER AND CABBAGE WORMS.*

F. A. SIRRINE.

SUMMARY.

This mixture should be called resin-lime mixture.

The tests made with resin-lime mixture and Paris green show that late cabbage and cauliflower can be protected from the attacks of the cabbage worm and the cabbage looper by two sprayings.

The tests also show that in the case of cabbage the yield can be increased 60 per cent to 100 per cent.

The cost per acre will depend upon the number of acres sprayed, the cost of spraying 10 acres twice being about $20.00.

A power sprayer cannot be used to apply the above mixture to cabbage and cauliflower.

Only skilled workmen should be trusted with the spraying of cauliflower.

The resin-lime mixture with an arsenite added must not be applied to cabbage after the heads are two-thirds formed nor to cauliflower after the " flower " is exposed.

* Reprint of Bulletin No. 144.

RESIN-LIME MIXTURE.

A formula for making a spraying mixture to be used on cabbage was given in Bulletin No. 120 of this Station. Notes on the use of the same mixture were also given in the Fifteenth Annual Report under the heading "Notes on Cabbage Plusia and Remedies for the Same." Tests of this mixture are now complete, hence all previously published tests are repeated at the present time. In the published notes above referred to, this mixture is called a "Poisoned resin-lime mixture." This name is appropriate only when the mixture contains Paris green or other arsenites and is used against leaf-eating insects. As the mixture is likely to be of value in other ways than as a carrier of insecticides a more appropriate name will be simply resin-lime mixture. The name cannot be shortened more than this for the reason that we already have a resin mixture which is used against scale insects and a distinction must be made between the two.

PREPARATION.

The resin-lime mixture is prepared as follows:

Stock Solution.—

Pulverized resin	5 pounds.
Concentrated lye	1 pound.
Fish oil or any cheap animal oil except tallow	1 pint.
Water	5 gallons.

It takes about 2 hours to prepare this mixture. The oil, 4 more gallons of hot water[1] should be placed in iron kettle and heated until the resin is softened, after which the solution of concentrated lye,[2] or potash, should be carefully added and the

[1] In the bulletin and report above referred to it was recommended that the oil and resin be placed in the kettle and heated before adding the water. The resin is softened most readily by this method but the oil and resin get so hot, that, when water is added, the latter is converted into steam and the whole mass is liable to be thrown out of the kettle.

[2] The solution of lye should be prepared according to the formula for making hard soap, which is always given on the can.

mixture thoroughly stirred. After the lye has been added, add 4 more gallons of hot water and allow the whole mass to boil until the mixture will unite with cold water, making a clear, amber colored liquid.[3] When through boiling if there is not five gallons of the mixture add water enough to make that quantity.

Solution for use.—

Resin mixture (stock solution)	1 gallon.
Water	16 gallons.
Milk-of-lime	3 gallons.
Paris green	1-4 pound.

To 1 part of the resin mixture add 16 parts of water and 3[4] parts milk-of-lime[5] or whitewash, after which add Paris green, or other arsenites, at the rate of 1 pond to every 80 gallons of the resin lime mixture. Resin lime mixture should only be prepared as used. If allowed to stand any length of time it will settle. The resin mixture is in reality a liquid soap, and when milk of lime is added to the diluted resin mixture the lime flocculates, or forms a hard soap of the saponified resin, which floats in the water. When Paris green is added the particles of the latter adhere to the flocculated resin and the mixture remains suspended in the water nearly as well as does Bordeaux mixture. If the milk-of-lime is added to the undiluted resin mixture a heavy precipitate is formed. This not only settles rapidly, but it also gums up the valves and plunger of the pump and clogs the nozzles of the spraying outfit.

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[3] If the mixture is added to cold water before all the resin has been sponified it will form a stringy mass in the water.

[4] In previous report it was recommended that 4 gallons of milk-of-lime be used. This quantity of lime flocculates nearly all the resin soap in the mixture. It has been found best to have an excess of the resin mixture, hence less milk-of-lime should be used.

[5] Milk-of-lime is made by slaking a quantity of stone lime of the best quality and adding enough water to make a thin whitewash.

TESTS.

This resin lime mixture with Paris green added was first tested in 1895 on elm trees for the elm leaf beetle. The mixture was applied but once, about June 10, both sides of the leaves being thoroughly sprayed. On August 1 the leaves of the sprayed trees were nearly perfect, while those on adjoining unsprayed trees consisted principally of veins and midribs to indicate what had once been leaves.

September 13, 1895, the resin lime mixture, with Paris green added, was used to spray a patch of rutabagas (smooth leaved, or Swedish, turnips). This patch was badly infested with the cabbage worm.[6] Three days after treatment not a living worm could be found on the patch. Although heavy rains followed the spraying, enough of the mixture adhered to the leaves so that no later broods of the worms succeeded in getting a foothold on the sprayed plants.

ON CABBAGE.

In 1896 two separate tests of the resin lime mixture with Paris green were made on cabbage against the cabbage looper and the cabbage worm. These tests were carried out on separate farms.

First test.— The first test was made on medium late cabbage, a mixture of Savoy, Flat Dutch, and Red Dutch varieties, part of which had commenced to head. For the sake of comparison Bordeaux mixture was used on part of the plats. On August 26 the plats were treated as follows:

Plat 1. Six rows, sprayed with resin lime mixture and Paris green.
Six rows, check.

Plat 2. Six rows, sprayed with Bordeaux mixture.[7]
Six rows, check.

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6 Throughout this bulletin the term "cabbage worm" is used for "imported, or European, cabbage worm" (*Pieris rapae*) also "cabbage-looper" or simply "looper" is used instead of "cabbage Plusia" (*Plusia brassicae*).

7 Bordeaux mixture used alone adhered only in the folds of the Savoy varieties, but where resin mixture was added it adhered as well as did the resin lime mixture.

Plat 3. Six rows, sprayed with Bordeaux mixture and Paris green.
Six rows, check.

Plat 4. Two rows, sprayed with resin mixture and Paris green, no lime.
Two rows, check.

Plat 5. Two rows, sprayed with Bordeaux mixture, resin mixture and Paris green combined.
Two rows, check.

The cabbages were examined on September 4. Plats 1 and 5 were found to have nearly perfect foliage, with no living cabbage worms and but few loopers; the inner leaves of the cabbages on Plats 2 and 3 were badly riddled by worms of both species. Plat 4 was practically free of the cabbage worms, but showed many loopers.[8] The plats were resprayed on the day of examination, no change being made in applications. Upon subsequent examination, September 21, the results of the different treatments were about the same as at the first examination. The work of the worms on Plats 2 and 3 was more marked, the cabbages on these, as well as on the check plats, being worthless. Many worms were also found on Plat 4, but none on Plats 1 and 5.

Salt.— On August 31st the owner of the field treated an acre of cabbage adjoining the sprayed plats with salt. When inspected on September 4 not a dead cabbage worm could be found on the whole acre; instead, plenty of living specimens were found with salt adhering to them and apparently not injured in the least.[9]

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[8] The condition of Plat 4 indicates that the resin mixture used alone does not carry enough Paris green to kill the cabbage looper. So many of the cabbage worms were pupating at the time that accurate conclusions as to results could be drawn.

[9] This brood of the cabbage worm commenced to pupate or enter the chrysalid stage a few days after treatment with the salt. As the worms commenced to disappear soon after the salt treatment the owner of the crop decided that salt had laid them out, while in reality the worms were simply crawling away to hiding places to transform into the chrysalid stage. Too many such tests of salt, flour, road-dust, fertilizers, and similar nostrums seem to yield good results when used against caterpillars or worms, if used

This salted acre never developed nor yielded any better than the checks of the sprayed portions of the field.

Second test.— The second test was made on the farm of F. P. Baylis, Floral Park, N. Y. The field contained 5 acres of very late cabbage; only one-half acre was sprayed, the remainder of the field being treated with dry Paris green and flour by the owner. The majority of the plants had only 5 or 6 leaves at the time the first treatment was made, August 29.

Plat 1. Two rows each of Savoy and Flat Dutch, sprayed with resin lime mixture and Paris green.
Two rows each of Savoy and Flat Dutch, check.

Plat 2. Two rows each of Savoy and Flat Dutch, sprayed with Bordeaux mixture.
Two rows each of Savoy and Flat Dutch, check.

Plat 3. Two rows each of Savoy and Flat Dutch, sprayed with Bordeaux mixture, resin mixture, and Paris green combined.
Two rows each of Savoy and Flat Dutch, check.

These plats were examined August 31; plenty of dead, and very few living, worms of either the cabbage looper or the cabbage worm were to be found on either variety of cabbage on Plats 1 and 3; plenty of living, and no dead, worms were found on Plat 2. On September 4, after heavy rains, the plats were re-examined. To all appearances there was little if any difference in the adhesive qualities of the Bordeaux mixture and the resin lime mixture when used separately, but the latter mixture was more evenly distributed over the leaves than was the Bordeaux mixture. The Bordeaux mixture adhered simply in the folds of the leaves.

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under the same conditions as the above test of salt. The caterpillars or worms are not noticed until they are nearly full grown, and then the tester salts, with the result that the worms are disturbed and crawl away to pupate instead of dying. Most kinds of caterpillars if irritated or disturbed when nearly full grown will stop feeding and crawl away to pupate. The butterflies and moths resulting from such caterpillars are not always perfect specimens but they are capable of reproducing themselves.

A second application was made September 17. At this time Paris green was added to the Bordeaux mixture used on Plat 2. No attempt was made to respray the lower outside leaves as they were still protected by the material applied the first time. Examination of the work on September 21 showed that on Plats 1 and 3 all the cabbage worms, as well as the loopers, had disappeared. Many dead specimens of each were found. Many of the cabbage worms had disappeared from Plat 2, but no dead specimens were found here. They had apparently crawled away to pupate. Plenty of living loopers were found on Plat 2.

After two heavy rains the plats were re-examined September 29. Very little, if any, difference could be seen in the amount of material still adhering to the plants of Plat 2, as compared with Plats 1 and 3; but a marked difference could be seen in the plants themselves.[10] The leaves of the plants on Plats 1 and 3 were nearly perfect, while those on Plat 2 were completely riddled, as were also those of the checks.

Paris green and flour.— On September 1st the owner treated 4 1-2 acres of the field with a mixture of dry Paris green and flour. When examined, September 4, no dead cabbage loopers could be found, but the treatment had disposed of a large number of the cabbage worms.[11]

A final comparison of the tests was made October 19. On Plats 1 and 3 the cabbage had formed marketable heads, while that of Plat 2 had made no better growth than the checks; in

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[10] This indicates one of two conditions; either there must be enough of the resin lime mixture adhering to the under surface of leaves to kill the worms, or there is an invisible film of the mixture on the upper surface holding Paris green enough to do the required work.

[11] The cabbage looper is an active caterpillar and at the same time sensitive about what it eats. If any foreign substance occurs on a leaf and the looper can possibly find leaves that are clean it will not touch those that are covered with foreign substance. This habit probably accounts for the fact that the looper was not killed by the treatment with Paris green and flour. Such a mixture only adheres to the upper surface and in the folds of the leaves at best, hence the looper is able to find food without feeding upon the treated areas.

fact, it was worthless. The difference between Plats 1 and 3, as compared with Plat 2 and checks, was so marked that it could be seen from a distance without going into the field. The difference between Plats 1 and 3, and the portion of the field treated with dry Paris green and flour was not marked until after the second spraying. At the time the last examination was made a few loopers had found their way from the checks to the heads on Plats 1 and 3, but all the cabbage worms had disappeared.

The following letter from Mr. F. P. Baylis gives the estimated condition of the crop at time of gathering and shows the value of spraying with the resin lime mixture fairly well:

"FLORAL PARK, N. Y., *Nov.* 22, 1897.

"Dear Sir: In reply to yours of the 19th inst., the white cabbage sprayed in fall of 1896 was fully 100 per cent better than where not sprayed at all, and at least 60 per cent better than where Paris green and flour were used. There was not so much difference when used on Savoy cabbage. The sprayed was better than where 'Green' was used, but only about 30 per cent. I think this is owing to the nature of the Savoy, which will make quite some growth after cold weather sets in and the worms are destroyed. Yours very truly,

"F. P. BAYLIS."

ON CAULIFLOWER AND BRUSSELS SPROUTS.

In 1897 further tests of the resin lime mixture combined with Paris green were made on cauliflower and Brussels sprouts at Baiting Hollow, N. Y.

The first test was made May 26.[12] A field of cauliflower, the plants of which had only 3 or 4 leaves was sprayed with the resin lime mixture. At the same time seedbeds of later cauli-

[12] Only the cabbage worm was attacking the plants at this time.

flower were sprayed with the same mixture, as was also a trap-crop[13] of rutabagas which had been set on the border of the field.

When the plants were examined, June 2, a few dead worms were found. The plants had been so severely attacked by the cabbage root maggot that the field had to be reset. This was done on June 5, the plants being dipped, roots and all, into the resin lime mixture before setting. This treatment was too severe for the plants.

A third attempt was made to get a stand of medium early cauliflower, but the plants were obtained from a seed bed infested with club-root, hence the crop proved a failure.

Very few worms were to be found throughout the summer on the trap-crop.

Another attempt was made to test resin lime mixture on cauliflower, also on Brussels sprouts. In a field of nearly 10 acres about 1-2 acre of cauliflower and 1-4 acre of Brussels sprouts were sprayed with the mixture[14] on August 31. Inspection of the work on September 8 showed that many of the cabbage worms, also caterpillars of the cabbage Plutella, or diamond backed moth, had been killed. No dead loopers were found. The field was resprayed September 29. Many of the cauliflower plants were heading and could not be sprayed at time of the second application. When examined, October 15, the sprayed

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13 Rutabagas were set on the margins of the field, the object being to furnish plants at which all the butterflies of the cabbage worm in that vicinity could collect and deposit their eggs, and by keeping these plants sprayed throughout the summer with the resin lime mixture and Paris green, to minimize the number of worms. The rutabagas were set several weeks before the cauliflowers were put out. This method is of little value on Long Island, for the simple reason that Siberian kale, and frequently Brussels sprouts and cabbage stumps are left on the fields over the winter and during the spring. These together with wild radish which grows plentifully along fences and in neglected fields furnish abundant places for the butterflies to deposit their eggs.

14 An attempt was made to spray cauliflowers with Paris green and Bordeaux mixture combined; such a small amount of this adhered to the leaves that the test was abandoned. Most of the loopers were found spinning cocoons at the time of spraying, August 31. The resin lime mixture was applied with a knapsack sprayer.

plants were found to be practically free, not only from the cabbage worm, but also from the looper. Worms from a late brood of the latter were abundant on the unsprayed portions of the field.

As a whole, the tests on cauliflower were not as thorough nor results as marked as on cabbage sprayed in the fall of 1896. This was partially due to the size of the plants at time of first spraying, but more to the position in which the leaves of the cauliflower grow, it frequently being impossible to get the mixture on the upper and inner surface of the leaves. Hence cauliflower cannot be protected as well as can cabbage. Plates I to V give some idea of the difference between the sprayed and the unsprayed cauliflowers, and the following letter from Mr. B. E. Goodale, on whose farm the spraying was done, gives his opinion of the value of spraying cauliflower:

"BATING HOLLOW, N. Y., *Oct.* 19, 1897.

"Dear Sir: In reply will say that the last spraying did the work well. I am satisfied that it would have paid me to have sprayed the entire field. The worms are raising the mischief this year. I do not see but very little of the mixture at this time adhering to the leaves that I leave as a protection. You might detect a little on the outside row of leaves.

"I do not think it would be of any practical use to spray later than we made the last spraying.

"Yours truly, B. E. GOODALE."

ON LETTUCE.

During the fall and winter of 1897 and 1898 the following tests of resin lime mixture combined with Paris green were made on lettuce in forcing house:

On October 27 lettuce[15] in flats was sprayed with resin lime mixture and Paris green, using same strength as used on cabbage and cauliflower. Cabbage loopers were collected from cabbage in

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[15] **This lettuce had from 3 to 4 leaves at time of spraying.**

field and placed upon the sprayed lettuce. The next day very few of the worms were found dead. Most of them had crawled away and were spinning cocoons. Wherever the resin lime mixture caused the leaves to stick together the plants were injured.

A second lot of lettuce was sprayed with resin lime mixture and Paris green on November 3, using same strength as before. Smaller specimens of the looper were placed upon the sprayed plants. Fifteen out of the 17 placed upon the plants were found dead the next day. The leaves of the plants were injured quite badly by the mixture.

On December 14, two varieties of lettuce (Rawson Hothouse and White Cos), plants 1-3 grown, were sprayed with the resin lime mixture, using resin mixture at the rate of 1 gallon, water 32 gallons, bulk of lime 6 gallons and Paris green 1-4 pound. This treatment destroyed all the loopers[16] on treated plants; but at the same time it slightly injured the plants where the leaves were gummed together.

February 24, 1898, two varieties of lettuce were sprayed with the resin lime mixture, the following proportions being used: Resin mixture 1 gallon, water 64 gallons, milk of lime 8 gallons, Paris green 1-2 pound. On March 2, this lettuce was found not injured in the least by the mixture, and no live loopers were found on the sprayed plants.

COST OF SPRAYING.

From the tests made in 1896 on cabbage it was estimated that 1 man could prepare the resin lime mixture and spray 2 acres a day with a knapsack sprayer. It was also estimated that 40 gallons would spray 1 acre. The above estimate is based on the assumption that a good supply of the stock solution of the resin mixture is prepared beforehand, and that the cabbage is two-thirds grown. Nearly double this amount of small cabbage can be

16 At the time of spraying, December 14 and February 24, the loopers were breeding in the forcing house.

sprayed in 1 day. Not much over 2 acres of cauliflower, large or small, could be sprayed in 1 day, as more care must be used in doing the work. At least 2 applications should be made on late cabbage and cauliflower. This would require 1 pound of Paris green to each acre. The entire cost of materials used would not exceed 50 cents per acre for 2 sprayings. Hence the principal cost of spraying would be the labor required to prepare and apply the mixture. One man could prepare enough of the stock solution of resin mixture in one-half day to last the whole season. From the foregoing estimates the whole cost of spraying a given number of acres can be easily calculated. For 10 acres, the cost of materials would be $5.00; allowing $1.50 per day for labor, the cost of preparing the stock solution of resin mixture would be 75 cents and the cost of making 2 applications to 10 acres would be $15.00, making a total of $20.75.

REASONS WHY RESIN LIME MIXTURE IS PREFERABLE TO OTHER SUBSTANCES.

Ever since the introduction of the European cabbage butterfly into this country, growers of cabbage have been using various materials and measures in an endeavor to prevent its ravages. Some of these means have yielded fair results, but more have proven worse than useless when carefully tested.

There are several reasons why better success has not followed the use of a few of the most reasonable measures that have been adopted. Chief among these is the fact that it is a difficult matter to make any of the substances that have been used adhere to the foliage of the plants on which the cabbage worm feeds. As a general rule growers of cabbage have only used insecticide in the dry or powder form. These were easily removed by the first light rain. Furthermore, the method of growth and the smoothness of the leaves of cabbage are such that not more than one-tenth of the leaf surface is protected by such remedies. Another factor has been that usually no effort is made to prevent the work

of the worms until considerable damage has been done. In other words, no insecticide is applied until fall, and then not until after the worms are nearly one-half grown, with the result that never more than one-half of them are destroyed. A third reason, and one on which the preceding partially depends, lies in the habits of the cabbage worm and its butterfly and of the cabbage looper and its moth. To show these the life history of each must be briefly reviewed.

CABBAGE WORM.

(*Pieris rapae.*)

LIFE HISTORY AND HABITS.

Worms of the last fall brood pass the winter in the chrysalid or pupal form. These chrysalids are attached to the under side of rails, sticks and dry weeds, and also to the sides of buildings or any place where they can obtain some protection from excessive moisture.

The white butterflies issue from the chrysalids the latter part of April and during May. They sometimes appear early in April, if the weather is warm for several days. After pairing, the female butterflies lay their eggs on whatever suitable plants can be found at that season of the year, on old stumps of cabbage growing in neglected fields, cabbage set out for seed purposes, Early Wakefield cabbage, Siberian kale (" sprouts ") and on such weeds as wild radish, mustard and cresses. Probably, on Long Island, the latter plants, especially wild radish, are the principal ones on which the worms of the first spring brood exist. The eggs of the butterflies are usually deposited singly on the lower and outer surface of the leaf, each female butterfly laying from 100 to 300 eggs. The egg laying of the first brood extends over a period of about 3 weeks. From 5 to 10 days are required for the eggs to hatch. After hatching from the egg the worms feed for a period of about 10 or 12 days.

They usually feed upon the under side of the leaves until half grown. When through feeding they crawl away and change to chrysalids, in which condition they remain for about 12 days, then issue as adult butterflies. The worms from the first eggs to hatch are nearly through feeding by the time the parent butterfly is through laying eggs. Hence butterflies of the third brood often appear before those of the second brood have disappeared. This makes it impossible to say definitely how many broods occur on Long Island. Undoubtedly there are more broods one year than another, depending on an early spring and a late fall.

In spite of weather conditions, parasites and enemies, there are generally myriads of these pests the latter part of September and during October. In addition to the plants named as furnishing food for the first brood of worms, the broods appearing the last half of the summer feed upon cauliflower, Brussels sprouts, ruta-bagas, mignonette, nasturtiums and a few other plants. The distribution of the spring food plants combined with the work of the enemies and parasites of the cabbage worm often produces local distribution of the spring brood of worms. Frequently in the spring the butterflies will be seen very thick over a section varying from a few miles to 10 miles square; while a mile from this section only occasionally a lone specimen will be seen flying. This local distribution often extends well into the fall. As a result the farmers in some sections see very little of their work and adopt no means of fighting them. At the same time farmers in other sections may be doing their best to get rid of them, with the final outcome that enough survive each year, if evenly distributed, to stock the whole country.

CABBAGE LOOPER.

(*Plusia brassicae.*)

In Bulletin No. 83 (December, 1894,) it was stated that without exception the cabbage worm was the worst cabbage pest that market gardeners have to contend with. This statement must at

the present time be modified, for the cabbage looper is not only as numerous, but it is more difficult to combat than is the cabbage worm. It is also a more general feeder, hence more plants must be protected from its ravages. Writers on entomology have always given the cabbage looper credit for doing more damage in the South than in the North. Whether the marked increase in the amount of damage done the past few years on Long Island is due to the fact that this section furnishes favorable southern conditions, or whether the looper is gradually migrating north, is not known.

DESCRIPTION.

As the cabbage looper is not generally as well known as the cabbage worm a short popular description is given.

Adult or moth.— The male is distinguished from the female moth or miller by having a distinct tuft of reddish-brown hairs on each side of the abdomen near the cauda, or tail; the cauda itself being covered with a short tuft of dark drown hairs. Both male and female moths have the fore wings mottled with dark brown, brown and white; so that, when resting on the ground, they resemble the soil. On the upper surface near the center of each forewing there is a silvery white mark, which in most cases resembles the figure 8; occasionally it is simply a dot-and-dash-like mark. The head and fore-body (thorax) are dark, ashy grey, mottled with brown. The abdomen, or hind-body, and hind-wings are fawn color, varying to a dark brown near the outer margin, the latter bordered with white. See Figs. 1 and 2, Plate XLII. When spread the wings measure from one to one and one one-half inches.

Egg.— The egg is about as large as a black mustard seed, and shaped somewhat like a turnip. It is ribbed, and in color is nearly pure white. (Plate XLII, Fig. 3.)

Larva or caterpillar.— When about one-fourth grown the caterpillar, or looper, is nearly as dark green as the cabbage worm and is distinctly marked on the sides of the body with longitudinal

white lines. By the time they are one-half grown they change to a pale green color and the white lines on the sides of the body become indistinct. These white lines usually disappear by the time the caterpillar is full grown. The looper does not have as many prolegs as most of the caterpillars, to which they are closely related, hence they loop the body when traveling. There are a few solitary hairs on the body. The head is small. When full grown they are about one to one and one-fourth inches long.

Pupa or chrysalis.— When first formed the pupa is light green in color, but soon changes to a dark brown and sometimes black. It can be found enclosed in a thin, white, transparent cocoon, which is spun by the caterpillar, usually in the fold of the leaf.

LIFE HISTORY AND HABITS.

The life history of the looper is somewhat similar to that of the cabbage worm, but in habits it differs considerably. This makes it a more difficult pest to handle. It is known that part of the last brood of loopers pass the winter in the chrysalis stage, but it is quite probable that many of them live over winter as moths or millers. The moths have been taken around the flowers of chickweed on warm days in December and also in March. About the same length of time is required for the hatching of the eggs and the growth of the caterpillars as for the cabbage worm. All the stages except the chrysalid are shown on Plate XLII. The different broods of the cabbage looper overlap and are mixed worse than in the case of the cabbage worm. Undoubtedly the number of broods each year exceeds that of the cabbage worm, as indicated by the moths and loopers being found at work earlier in the spring and later in the fall. When full grown the loopers crawl to the under side of a leaf of the plant on which they are feeding and spin a loose silken cocoon around themselves, then change to chrysalids.

Moth.— In habits the moths differ considerably from the cabbage butterfly. They are rarely seen on the wing except during

cloudy days, or late in the afternoon and early evening. Sometimes they will be seen at flowers, but usually these are male moths. If the female moth is noticed on the wing, she is usually darting rapidly from one plant to another hiding under the leaves to deposit her eggs. The eggs are usually deposited singly, but occasionally 3 or 4 eggs will be found in close proximity on the same leaf. Each moth lays about the same number of eggs as does the cabbage butterfly. On Long Island the first eggs are deposited on the same plants as are those of the cabbage butterfly, and on chickweed and spinach in addition. Later in the season they apparently are not confined to any particular plants while depositing their eggs. The fact that they are swift flyers and are dusky colored probably accounts for their not being seen during the day. Some writers claim that the moths of the cabbage looper are night flyers. They surely do considerable flying during the day, and I have been unable to capture them at light-traps. This would indicate that they are no more night flyers than is the moth of the corn worm.

Feeding habits.— The loopers will feed on almost any plant that is succulent and tender, showing very little choice while food is plentiful. After midsummer when food becomes scarce they do their principal feeding upon cauliflower, lettuce and cabbage, but they are not averse to feeding upon any of the following economic plants: Siberian kale ("sprouts"), kale, broccoli, Brussels sprouts, rape, spinach, celery, tomatoes, cannas, chrysanthemums, carnations, smilax, heliotrope, pelargoniums and various other forcing house plants. They are especially destructive to lettuce in forcing houses, where they will feed and breed all winter. Although they will feed upon almost anything that is green they always show a dislike for old, tough leaves and for leaves that have any foreign substance on the surface. In fact they will not feed upon such leaves unless starved to do so. In cases where cabbage is treated with a dry insecticide it is an easy matter for them to find portions of the plant that are not covered with

the insecticide, and thus escape being killed. Where headed cabbage, which throws out no new leaves, is left standing on the field they eat into the solid heads. During the day they usually feed from the under or lower surface of a leaf, but probably they do the most of their feeding at night. The habit of feeding from the under side of a leaf gives them a chance to hide and at the same time be protected from the sun. When feeding upon such plants as carnations they hide during the day in a position to resemble a leaf or branch of the plant. They are sure to find the most tender portion of a plant such as the buds and growing tips. They like nothing better than to feed upon the flower of a cauliflower after it has been tied. Their appetites are generally good. A medium-sized looper will devour a lettuce plant having 4 or 5 leaves in one night. They can travel quite rapidly and easily pass from one plant to another.

CONCLUSIONS.

Cabbage worm.— The fact that the eggs are deposited on the under or outer side of the leaf, and, that the worms do their first feeding on that part of the leaf, in fact in most cases feeding upon the under or lower surface of the leaves until nearly half grown, makes it essential that any poisonous insecticide should be on that part of the leaf to give complete results. The habit of feeding from the lower side of the leaves makes the use of all insecticides which kill by contact more or less impractical, at least until after the worms have done a large amount of damage. This habit is also often the cause of delay in treatment as they are not noticed until many of the worms are through feeding and ready to pupate.

The fact that the broods overlap so that eggs and full grown worms occur on the plants at the same time, assuming all other conditions to be favorable, makes it impossible to destroy them all with one treatment with any of the measures that have been

in use. In fact the combination of all conditions makes it impossible to destroy them all with two or three treatments by any of the measures previously used.

The numerous spring food plants to be found in this section make the use of trap-crops, or even the systematic spraying of early cabbage, impractical and more expensive than results warrant.

Many growers of cabbage never attempt to use remedies until after they see the ravages of the worms or the worms themselves. In such cases part of the worms are nearly through feeding, hence the treatment is far from complete in its results.

The numerous food plants, the varying habits of the worms and butterflies in adapting themselves to conditions, their feeding out of sight until quite large, combined with carelessness in the methods of combating them, all aid in making, in nine cases out of ten, the final results from the methods used almost nil.

Cabbage looper.— Undoubtedly the wariness of the looper with regard to feeding on foliage that has any foreign substance on its surface, combined with its activity, makes it one of the hardest to combat of the leaf-eating caterpillars. In all my work I have failed to find a dead looper on plants treated with remedies of any form used as dry powders. Possibly a few are killed by the use of dry Paris green and flour on cabbage, but they are very few. Light traps have been used in forcing houses but without success. The use of mosquito netting on the ventilators of forcing houses has been recommended but growers think this would not only be too expensive but also inconvenient and impracticable. Furthermore, in transplanting the first crop of lettuce from beds out of doors to forcing house, the eggs of the moths and of the worms themselves are carried in on the plants. If a half dozen perfect female moths get into a forcing house containing 2,000 square feet of bench room, they are able to deposit eggs on most of the plants. Hand picking is generally practiced for this pest on lettuce, but usually the rascal has a plant destroyed before he is picked.

It was with the intention of combating the looper that an effort was made to find a substance that could be made to adhere uniformly to the surface of the leaves of cauliflower and cabbage. Most of the tests given were made, and effects on cabbage looper noted, for this purpose. The results obtained on the cabbage worm were of secondary importance as compared with results sought on the cabbage looper. The tests have proven as satisfactory as could be expected.

The letters from Mr. Baylis and from Mr. Goodale show that the results were worth far more than the cost of treatment, although they considered the results obtained from the treatment of the cabbage worm as well as the looper. The results obtained from the treatment of cauliflower were not as satisfactory as those from the treatment of cabbage, but when we consider the character of the plant combined with the habits of the pests to be treated the results were better than should be expected. For the most part the leaves of cauliflower grow in a vertical position; hence it would be not only a waste of material but also of time to attempt to treat them with a dry insecticide. Fair results *might* be obtained on cauliflower by the use of insecticides which kill by contact, but these would only be practical while the plants are small and would need to be applied every week, as eggs and full grown caterpillars are liable to occur on the plants at the same time. As already stated the use of trap-crops is of doubtful value for the cabbage worn. They are surely of no value for the looper, even though combined with the removal of old cabbage stumps from the field and the destruction of weeds along roadsides and borders of fields, for, as has been shown, the looper has no fixed food plant. (It is not the intention to discourage the destruction of weeds on the borders of fields, or the clearing up of old cabbage fields. This should be done on general principles.) The capturing of the moth of the cabbage looper by any means is also impractical. Hence for this pest, as far as tested, we have no alternative but to use an

insecticide that will stay where it is put, and at the same time we must use some material that will carry enough poison to kill the loopers even though they eat but a small portion of the insecticide.

RECOMMENDATIONS.

The foregoing conditions show some of the reasons why better success is not obtained by the use of most of the numerous measures that are in vogue with the growers of cabbage against the cabbage worm. They also show how impractical the use of any of these measures will be when used for the looper. The results obtained in 1896 by the use of resin lime mixture and Paris green for the cabbage worm showed conclusively that the two applications, one made while the plants are small, and the second after they had commenced to head, yielded results at least 50 or 60 per cent better than did the use of Paris green and flour, although the latter is one of the surest of the old methods of treating the cabbage worm. The above results taken in combination with all the conditions that must be met leads us to recommend the spraying of late cabbage twice for the looper, at least once for the cabbage worm, with the resin lime mixture. (The term late cabbage is so variable on Long Island that no exact dates for spraying can be given.) If the applications are made with care all the leaves will be fairly well protected on both sides as the mixture stays where applied. It is not claimed that it will pay to apply the resin lime mixture except in the fall of the year. The results obtained from the use of resin-lime mixture on cabbage in 1896, and on cauliflower in 1897 against the cabbage looper, were just as marked; at least when we consider the amount of damage done by this pest, and, at the same time take into consideration its habits and the range of its food plants. Only two applications of the resin lime mixture are recommended for the cabbage looper, but these two applications must be thoroughly made and at the right time. In all cases the best results will be obtained if the first application is made on both cabbage and cauliflower when

the plants have about a dozen leaves, the second being made just before the plants commence to head, even though but few or no worms are to be seen at the time.

Usually for lettuce only one application of the resin lime mixture will be required, at least if combined with hand picking. For lettuce the following proportions must be used:

Resin mixture	1 gallon.
Water	64 gallons.
Milk of lime	8 gallons.
Paris green	½ pound.

This is not recommended as one of the best measures to be used for the protection of lettuce. We still believe that the proper use of mosquito netting would prove the most satisfactory even if a trifle the most expensive. The use of resin lime mixture is simply offered as a substitute that has been tried; a substitute to be used after a house has become infested.

When the fact is taken into consideration that with one application of resin lime mixture on cabbage and cauliflower two pests are disposed of, the expense of using it even as a preventive measure is slight. Probably the cost of spraying cannot be reduced much below the estimated amount, viz., about $1 per acre for each application even with added improvements, for the following reasons: First, a knapsack, or a barrel sprayer must be used. No power sprayer will do the work thoroughly on either cabbage or cauliflower. Furthermore, cauliflower heads so unevenly it would not only be impossible but unsafe to spray it with a power sprayer. Second, only intelligent and skillful labor should be employed to do the work. It is essential, for both the cabbage worm and for the looper, to get the mixture on the outer and under surface of the leaves, as well as on the upper surface. Furthermore, the workman must be familiar with the habits of cauliflower, able to tell at glance whether the whorl of leaves at the center is opening so as to expose the flower. *Such plants must not be sprayed.*

No man who stands 10 feet from a plant for fear of getting the mixture on his clothes, and who only sprays one side of a plant, should be employed. Neither is an awkward, stiff-wristed man of any use for this work. The work requires a man who is not afraid to get near enough to the plant to spray it from all sides by a simple turn of the wrist.

If a knapsack is employed for applying the resin lime mixture, a strongly-made machine must be used. We have found the "Garfield" quite satisfactory for this purpose. Such frail machines as the "Eclipse" knapsack sprayer have proven worthless for applying this mixture. The resin lime mixture gums the valves to such an extent that a frail machine is wrenched to pieces in a short time. The gumming of the valves by the resin lime mixture is the only disadvantage found in the use of the mixture, but no other mixture has been found that will adhere to the smooth leaves of cabbage and cauliflower, or plants related to them. Soapsuds can be flocculated with lime the same as the resin mixture, but it will not adhere as well. Where strong machines were used the only drawback from gumming was the requirement of a little more force in pumping, thus adding to the heaviness of the work.

DANGER FROM USE OF MIXTURE.

The question of danger from the use of an arsenite on such plants as cabbage, cauliflower and lettuce is important. It must be admitted in the case of cauliflower and lettuce that there is a point beyond which the use of an arsenite is dangerous. With cabbage there is no danger except in cases of gross ignorance, not only on the part of the grower, but also on the part of the consumer. The consumer would have to eat the outside leaves of cabbage in order to get any of the arsenite, besides the grower would have to be guilty of using the arsenite after the heads were completely formed in order that the consumer get the arsenite on the few leaves that are left on the outside as a protection to the head. Arsenites have long been used on cabbage in one form or another with no known ill effects.

If directions are carefully followed no ill effects will result from the use of arsenites on cauliflower and lettuce. We assume that men who can read are capable of using some judgment in the use of the resin lime mixture and Paris green. *It has been explicitly stated that this mixture should not be used on cabbage after the heads are two-thirds formed; that only skillful and intelligent laborers should be trusted with the application of it on cauliflowers; that it should never be applied after the "flower" has commenced to form.*

For the varieties of lettuce which form heads, it can be safely used until the plants are one-third grown. It must never be used on other varieties of lettuce.

PLATE XXXV.—RUINED CAULIFLOWER FIELD.

PLATE XXXVI.—CABBAGES RIDDLED BY WORMS.

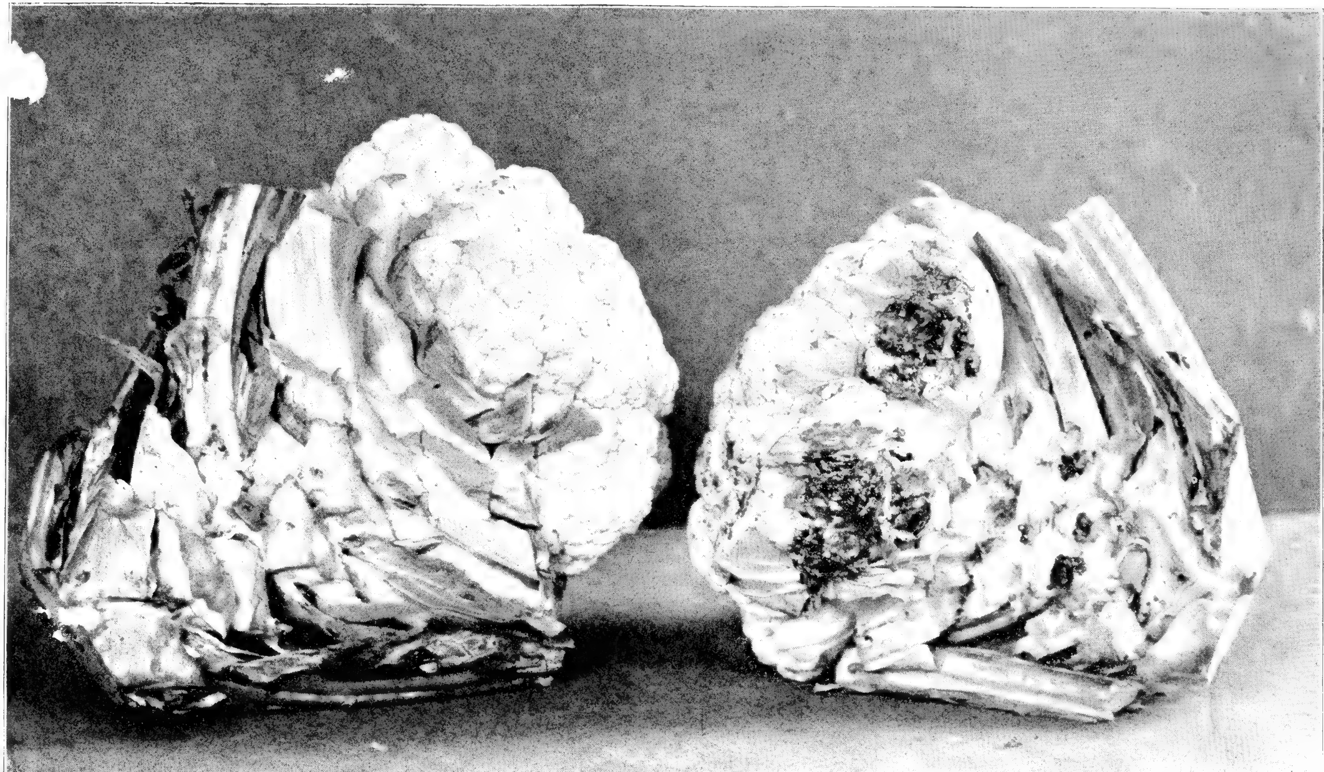

Plate XXXVII.—Side View of Sprayed (Left) and Unsprayed (Right) Cauliflowers.

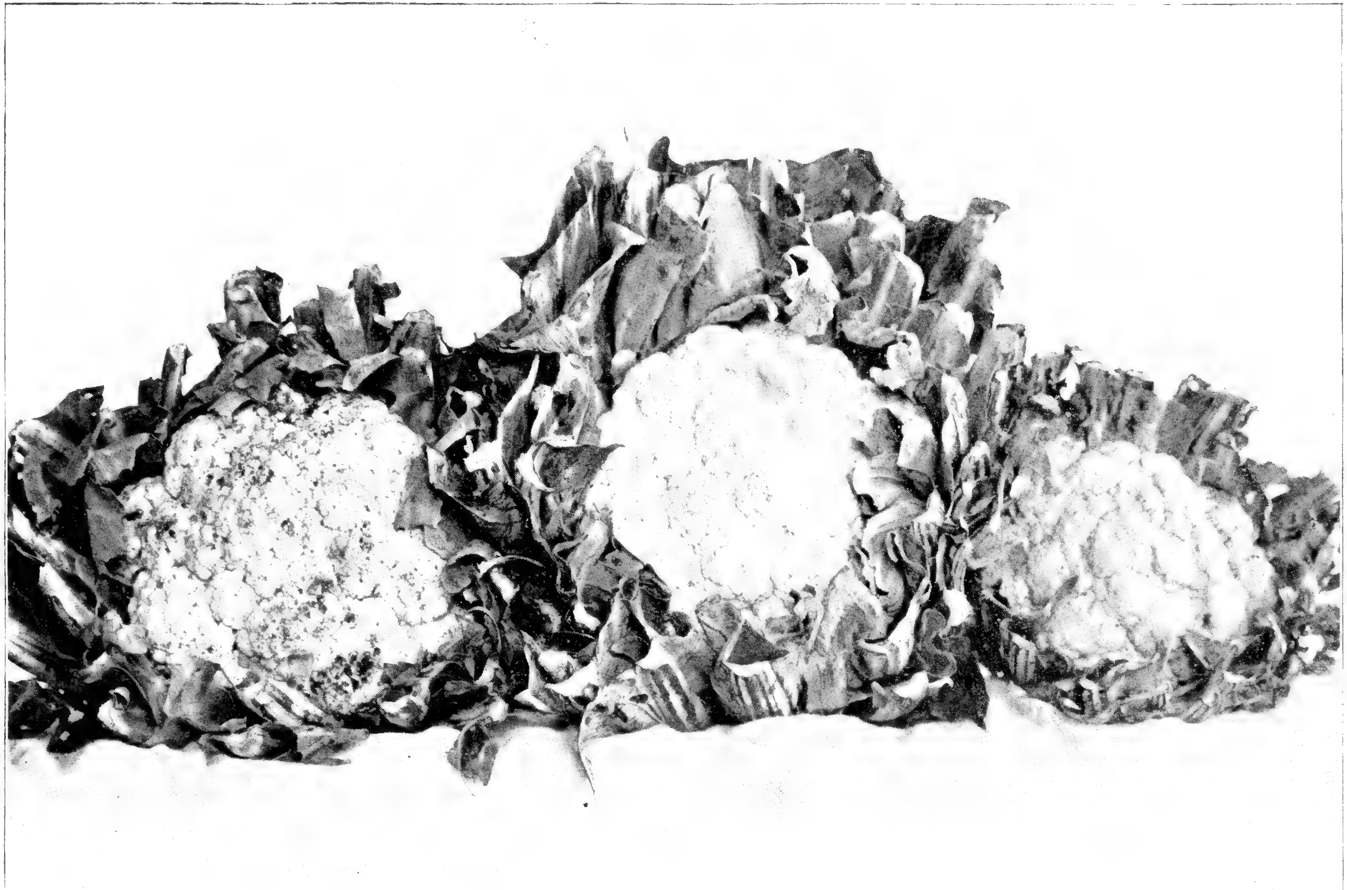

Plate XXXVIII.—Sprayed (Center) and Unsprayed (Outer) Cauliflowers Ready for Market.

Plate XXXIX.—Cauliflower Sprayed with Resin-Lime Mixture.

PLATE XL.—AN UNSPRAYED CAULIFLOWER.

PLATE XLI.—CAULIFLOWER TOO FAR ADVANCED TO BE SAFELY SPRAYED.

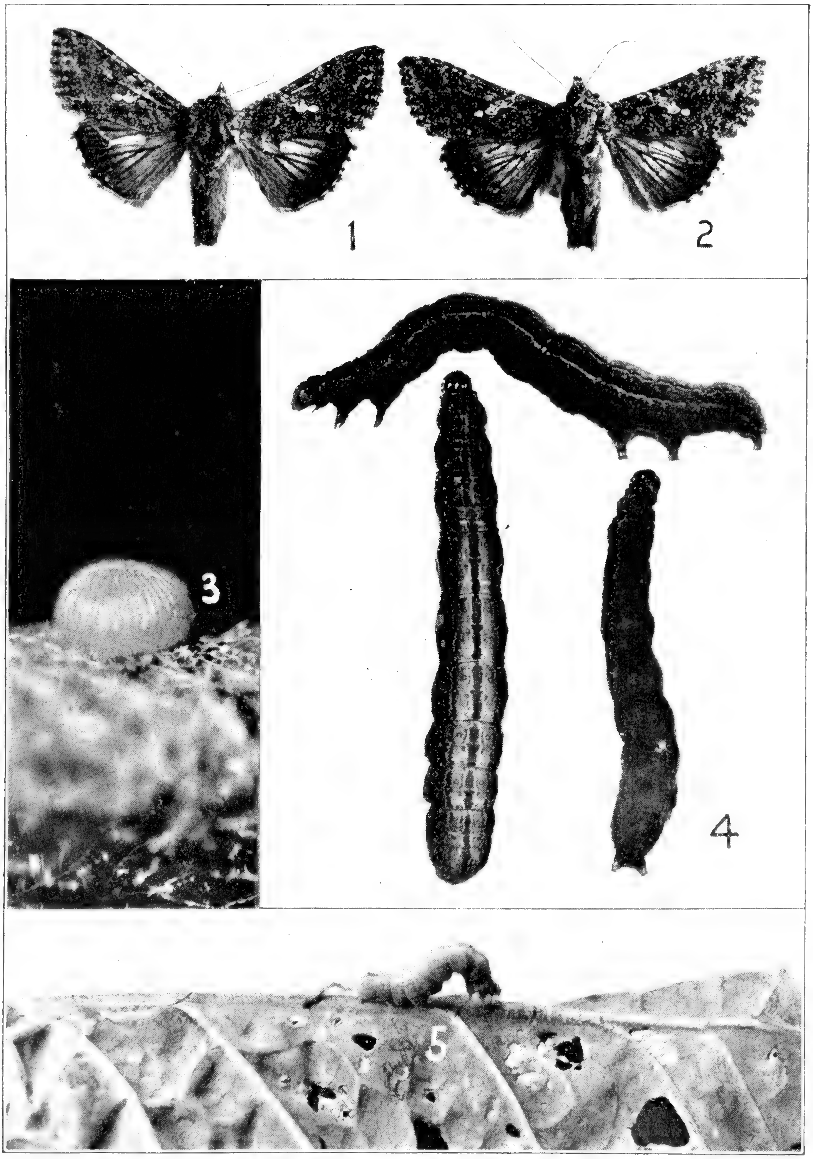

PLATE XLII.—FEMALE AND MALE MOTHS, EGG AND CATERPILLARS OF CABBAGE LOOPERS.

EXPLANATION OF PLATES.

Plate XXXV.— *Ruined cauliflower field.*

Plate XXXVI.— *Cabbages riddled by worms.*

Plate XXXVII.— (Left) *Side view of cauliflower that has been sprayed with resin lime mixture. Leaves cut away to show the "flower."*

(Right) *Side view of cauliflower that was not sprayed. Leaves cut away to show excreta of worms on "flower" and in axils of the leaves.*

Plate XXXVIII.— *Front view of sprayed and unsprayed cauliflowers trimmed ready for crating.*

(Center) *Sprayed;* (outer) *not sprayed. The spots on* (center) *are due to bruises from crating. Those on* (outer) *are due to the feeding of the worms and to their filth.*

Plate XXXIX.— *A cauliflower plant that was sprayed with the resin lime mixture.*

Plate XL.— *An unsprayed cauliflower plant.*

Plate XLI.— *A cauliflower with leaves cut away to show that the "flower" is too far advanced to be safely sprayed. Note filth of worms in the axils of the leaves.*

Plate XLII.— *The looper. Fig.* 1, *female moth;* 2, *male moth;* 3, *egg;* 4 *and* 5, *caterpillars. Figs.* 1 *and* 2 *enlarged one-fourth; Fig.* 3, *twenty times natural size; Fig.* 4, *twice natural size.*

All illustrations except Plate XLII, Fig. 5, photographed by L. V. Hallock under directions of the author.

REPORT

OF THE

DEPARTMENT OF FIELD CROPS.

W. H. Jordan, Sc. D., *Director.*

G. W. Churchill, *Agriculturist.*

L. L. Van Slyke, *Chemist.*

Table of Contents.

REPORT OF THE DEPARTMENT OF FIELD CROPS.

I. COMMERCIAL FERTILIZERS FOR POTATOES.*

W. H. Jordan.

SUMMARY.

The work described in this bulletin is a continuation of tests made in 1897, with added investigations. Unlike the results in 1897, when 1,000 pounds proved the limit of profitable application, 1,500 pounds gave most profit in 1898.

The Long Island formula (4, 8 and 10 mixture) gave better results than the fertilizer based on the composition of the potato, although the difference was less marked than in 1897.

The new tests included 64 eighth-acre plats on four farms and were planned to ascertain the effect of a full amount of potash as compared with two-thirds as much, one-third as much and none at all. The fertilizer without potash was as efficient as those containing it; so the variations in amount showed no influence.

INTRODUCTION.

Bulletin No. 137 of the New York Agricultural Experiment Station gives the results of the first year's effort at studying the economical use of commercial fertilizers in potato growing on Long Island.

* Reprint of Bulletin No. 154.

A detailed statement may be found in that bulletin of the reasons for taking up that line of work, the conditions involved and the arrangement of the experiments as planned and executed in 1897. The situation, briefly summarized, was as follows:

(1) Farmers on Long Island were found to be quite generally using 2,000 pounds of high grade commercial fertilizers per acre in growing potatoes, an amount largely in excess of the needs of a single crop.

(2) Experiments for two years by Dr. Van Slyke indicated that 1,000 pounds per acre was the maximum profitable quantity, but his experiments did not show what would follow during a series of years.

(3) A general opinion appeared to prevail that the sulphate of potash was preferable to the muriate in potato growing chiefly on account of the effect of the latter on the quality of the product.

(4) A fertilizer formula based on the composition of the crop is urged by some. On the other hand the farmers of Long Island had very generally come to adopt what is known as the 4, 8 and 10 formula, the economy of which seemed to have no general support except the somewhat inconclusive approval of common practice.

The experiments as conducted in 1897 were planned, therefore, with reference to answering the following questions:

(1) What is the profitable quantity of commercial fertilizer to use in growing potatoes on Long Island?

(2) Is the 4, 8 and 10 formula better than one which recognizes only the composition of the crop?

(3) Is the sulphate of potash better than the muriate for potato growing, quantity and quality both considered?

The results for a single season (1897) taken by themselves without reference to the influence of continued practice gave the following indications, viz.:

(1) That more than 1,000 pounds of fertilizer was used at a loss.

(2) That the 4, 8 and 10 formula is somewhat more efficient than the "potato formula."

(3) That muriate of potash produced no definite deleterious influence on the quality of potatoes.

EXPERIMENTS IN 1898.

The experiments of 1897 have been repeated in 1898, in accordance with the plan to continue them for a series of years.

The work has been enlarged, however, by the addition of four more formulas or mixtures of fertilizing ingredients designed to test the use of such large quantities of potash salts as appears to be the custom on Long Island and in other localities.

The 4, 8 and 10 formula, to which reference has been made, calls for the application of more potash than of either nitrogen or phosphoric acid. Certain observations in connection with former experiments led the writer to doubt the wisdom of this practice, though not to deny it, consequently an additional acre was secured on each of the four farms where potato experiments are in progress, to be devoted to experiments with varying amounts of potash salts.

THE FERTILIZERS USED.

The purposes of these experiments as now arranged require the use of eight different mixtures of fertilizing materials, the ingredients and composition of which are given below.

POTATO FORMULA.

This formula is supposed to contain plant foods in nearly the proportions used by the entire potato plant excepting that the phosphoric acid is in considerable excess. Two mixtures were used:

MIXTURE No. 1.

Ingredients.		*Composition.*	
Nitrate of soda..........	192 lbs.	Nitrogen	7.0 per ct.
High grade dried blood..	900 lbs.	Available phos. acid....	4.0 per ct.
Acid phosphate	508 lbs.	Potash	10.0 per ct.
Muriate of potash	400 lbs.		
	2,000		

MIXTURE NO. 2.

This mixture contains the same percentages of the three ingredients as Mixture No. 1, the only difference being that the potash is supplied as the sulphate instead of the muriate.

Ingredients.		*Composition.*	
Nitrate of soda..........	192 lbs.	Nitrogen	7.0 per ct.
High grade dried blood..	900 lbs.	Available phos. acid....	4.0 per ct.
Acid phosphate	508 lbs.	Potash	10.0 per ct.
Sulphate of potash......	400 lbs.		
	2,000		

L. I. FORMULA.

This formula is an imitation of the one so commonly followed by clubs of farmers on Long Island who purchase their fertilizers on the cooperative plan.

MIXTURE NO. 3.

Ingredients.		*Composition.*	
Nitrate of soda	127 lbs.	Nitrogen	4.0 per ct.
High grade dried blood..	500 lbs.	Available phos. acid....	8.0 per ct.
Acid phosphate	973 lbs.	Potash	10.0 per ct.
Muriate of potash	400 lbs.		
	2,000		

MIXTURE NO. 4.

This mixture is similar to No. 3, except that the potash is supplied as the sulphate instead of the muriate.

Ingredients.		*Composition.*	
Nitrate of soda	127 lbs.	Nitrogen	4.0 per ct.
High grade dried blood..	500 lbs.	Soluble phos. acid......	8.0 per ct.
Acid phosphate	973 lbs.	Potash	10.0 per ct.
Sulphate of potash......	400 lbs.		
	2,000		

POTASH FORMULAS.

POTASH TEST FORMULA NO. 1.

Ingredients.		*Composition.*	
Nitrate of soda	127 lbs.	Nitrogen	4.0 per ct.
Dried blood	500 lbs.	Available phos. acid	8.0 per ct.
Acid phosphate	1,000 lbs.		
Land plaster	373 lbs.		
	2,000		

This formula furnished no potash, but the same amounts of nitrogen and phosphoric acid as the L. I. Formula.

POTASH TEST FORMULA NO. 2.

Ingredients.		*Composition.*	
Nitrate of soda	127 lbs.	Nitrogen	4.0 per ct.
Dried blood	500 lbs.	Available phos. acid	8.0 per ct.
Acid phosphate	1,000 lbs.	Potash	3.5 per ct.
Sulphate of potash	140 lbs.		
Land plaster	233 lbs.		
	2,000		

This formula furnished approximately one-third the potash contained in the L. I. Formula, and the same nitrogen and phosphoric acid.

POTASH TEST FORMULA NO. 3.

Ingredients.		*Composition.*	
Nitrate of soda	127 lbs.	Nitrogen	4.0 per ct.
Dried blood	500 lbs.	Available phos. acid	8.0 per ct.
Acid phosphate	1,000 lbs.	Potash	7.0 per ct.
Sulphate of potash	280 lbs.		
Land plaster	93 lbs.		
	2,000		

This formula furnishes approximately two-thirds the potash contained in the L. I. Formula and the same amounts of nitrogen and phosphoric acid.

POTASH TEST FORMULA No. 4.

This formula is identical with the L. I. Formula and need not be restated. The ingredients and composition of the mixture are similar to No. 4 under the head of L. I. Formula.

GENERAL COMPOSITION.

It was intended that approximately one-fourth of the nitrogen furnished by these mixtures should be nitric, and three-fourths organic nitrogen. The manufacturers who mixed the fertilizer were also instructed that the phosphoric acid should be as largely soluble as possible. The analyses of the four mixtures showed that these conditions were secured.

THE AREA AND ARRANGEMENT OF PLATS.

The total area under experimental treatment is twelve acres, divided into 120 plats of one-tenth acre in size.

This area is distributed equally on four farms, the arrangement of the plats and amounts and kinds of fertilizers being the same in each case.

FERTILIZERS APPLIED ON PLATS.

Potato Formula.	*L. I. Formula.*
Plat No. 1, no fertilizer.	Plat No. 11, no fertilizer.
Plat No. 2, 500 lbs., Mixture No. 1.	Plat No. 12, 500 lbs., Mixture No. 3.
Plat No. 3, 1,000 lbs., Mixture No. 1.	Plat No. 13, 1,000 lbs., Mixture No. 3.
Plat No. 4, 1,500 lbs., Mixture No. 1.	Plat No. 14, 1,500 lbs., Mixture No. 3.
Plat No. 5, 2,000 lbs., Mixture No. 1.	Plat No. 15, 2,000 lbs., Mixture No. 3.
Plat No. 6, no fertilizer.	Plat No. 16, no fertilizer.
Plat No. 7, 500 lbs., Mixture No. 2.	Plat No. 17, 500 lbs., Mixture No. 4.
Plat No. 8, 1,000 lbs., Mixture No. 2.	Plat No. 18, 1,000 lbs., Mixture No. 4.
Plat No. 9, 1,500 lbs., Mixture No. 2.	Plat No. 19, 1,500 lbs., Mixture No. 4.
Plat No. 10, 2,000 lbs., Mixture No. 2.	Plat No. 20, 2,000 lbs., Mixture No. 4.

Potash Test Formulas.

Plats 21 and 26.	No fertilizer.
Plats 22 and 27.	Formula No. 1.
Plats 23 and 28.	Formula No. 2.
Plats 24 and 29.	Formula No. 3.
Plats 25 and 30.	Formula No. 4.

TABLE I.— YIELD OF POTATOES ON ONE-TENTH ACRE PLATS.

Fertilizer.		Number of plat.	Amount of fertilizer per acre.	Potatoes on plats on farms of											
				Wm. A. Fleet.			H. L. Hallock.			W. L. Jagger.			R. H. Robbins.		
				Large.	Small.	Total.	Large.	Small.	Total.	Large.	Small.	Total.	Large.	Small.	Total.
			Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Potato formula.	Mixture 1.	1	0	948	126	1,074	233	187	420	404	153	557	389	265	654
		2	500	1,071	127	1,198	449	182	631	595	126	721	575	270	845
		3	1,000	1,333	136	1,469	553	182	735	771	94	865	644	270	914
		4	1,500	1,488	113	1,601	686	176	862	873	173	1,046	707	226	933
		5	2,000	1,513	112	1,625	756	194	950	921	185	1,106	652	230	882
	Mixture 2.	6	0	629	132	761	333	182	515	522	100	622	500	232	732
		7	500	846	114	960	449	176	625	681	141	822	557	264	821
		8	1,000	1,158	113	1,271	649	202	851	871	103	974	767	203	970
		9	1,500	1,484	101	1,585	898	217	1,115	854	106	960	752	176	928
		10	2,000	1,485	101	1,586	1,023	157	1,180	826	197	1,023	680	166	846
L. I. Formula.	Mixture 3.	11	0	830	121	951	181	228	409	306	133	439	537	180	717
		12	500	933	122	1,055	447	225	672	648	121	769	650	174	824
		13	1,000	1,007	128	1,135	617	182	799	740	146	886	745	180	925
		14	1,500	1,268	96	1,364	802	208	1,010	838	74	912	1,043	230	1,273
		15	2,000	1,354	108	1,462	834	202	1,036	896	145	1,041	917	261	1,178
	Mixture 4.	16	0	692	148	840	267	207	474	277	55	332	676	135	811
		17	500	1,101	137	1,238	575	100	675	517	79	596	819	240	1,059
		18	1,000	1,155	123	1,278	897	201	1,098	800	88	888	950	126	1,076
		19	1,500	1,223	94	1,317	1,171	190	1,361	832	106	938	1,042	197	1,239
		20	2,000	1,250	97	1,347	1,252	175	1,427	1,041	105	1,146	954	132	1,086

TABLE II.— AVERAGE YIELD OF POTATOES PER ACRE FROM DIFFERENT AMOUNTS OF FERTILIZER.

Experimenter.	No. of plats averaged.	Yield of potatoes with: No fertilizer. Large.	No fertilizer. Small.	No fertilizer. Total.	500 lbs. fertilizer. Large.	500 lbs. fertilizer. Small.	500 lbs. fertilizer. Total.	1,000 lbs. fertilizer. Large.	1,000 lbs. fertilizer. Small.	1,000 lbs. fertilizer. Total.	1,500 lbs. fertilizer. Large.	1,500 lbs. fertilizer. Small.	1,500 lbs. fertilizer. Total.	2,000 lbs. fertilizer. Large.	2,000 lbs. fertilizer. Small.	2,000 lbs. fertilizer. Total.
		Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
Wm. A. Fleet....	4	129.2	22.0	151.2	164.6	20.8	185.4	193.8	20.8	214.6	227.7	16.8	244.5	233.4	17.4	250.8
H. L. Hallock...	4	42.3	33.5	75.8	80.0	28.5	108.5	113.2	32.0	145.2	148.2	33.0	181.2	161.1	30.3	191.4
W. L. Jagger....	4	62.9	18.4	81.3	101.7	19.5	121.2	132.6	18.0	150.6	141.6	19.1	160.7	153.5	26.3	179.8
R. H. Robbins...	4	87.6	33.8	121.4	108.4	39.5	147.9	129.3	32.5	161.8	147.7	34.6	182.3	133.5	32.9	166.4
Average of all...	16	80.5	26.9	107.4	113.7	27.1	140.8	142.3	25.8	168.1	166.3	25.9	192.2	170.4	26.7	197.1
Av'ge inc. of y'ld					33.2		33.4	61.8		60.7	85.8		84.8	89.9		89.7

TABLE III.— RESULTS WITH POTASH TEST FORMULAS.
(Yield of potatoes on one-tenth acre plats.)

	No. of plat.	Amount fertilizer per acre.	Wm. A. Fleet			H. L. Hallock.			W. L. Jagger.			R. H. Robbins.		
			Large.	Small.	Total.	Large.	Small.	Total.	Large.	Small.	Total.	Large.	Small.	Total.
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
	21	0	485	190	675	721	140	861	1,092	158	1,250	583	170	753
Formula 1............	22	1,000	1,030	136	1,166	910	116	1,026	1,479	147	1,626	901	173	1,074
Formula 2............	23	1,000	1,051	87	1,138	919	128	1,047	1,535	185	1,720	870	263	1,133
Formula 3......	24	1,000	1,170	81	1,251	903	122	1,025	1,452	161	1,613	949	191	1,140
Formula 4............	25	1,000	1,271	82	1,353	944	143	1,087	1,329	157	1,486	959	171	1,130
	26	0	896	117	1,013	576	150	726	970	141	1,111	580	223	803
Formula 1............	27	1,000	1,325	95	1,420	770	107	877	1,275	135	1,410	871	245	1,116
Formula 2............	28	1,000	1,520	85	1,605	720	143	863	918	156	1,074	976	220	1,196
Formula 3............	29	1,000	1,224	110	1,334	740	154	894	1,057	122	1,179	1,067	220	1,287
Formula 4............	30	1,000	1,350	98	1,448	693	150	843	1,137	85	1,222	995	201	1,196

TABLE IV.— SUMMARY OF YIELDS PER ACRE OF POTATOES WITH VARYING AMOUNTS OF POTASH.

	Nothing.			No potash.			⅓ potash.			⅔ potash.			3-3 potash.		
	Large.	Small.	Total.	Large.	Small.	Total.	Large.	Small.	Total.	Large.	Small.	Total.	Large.	Small.	Total.
	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
Wm. A. Fleet ...	115.0	25.6	140.6	196.2	19.3	215.5	214.2	14.3	228.5	199.5	15.9	215.4	218.4	15.0	233.4
H. L. Hallock...	108.1	24.2	132.3	140.0	18.6	158.6	136.6	22.6	159.2	136.9	23.0	159.9	136.4	24.4	160.8
W. L. Jagger....	171.8	24.9	196.7	229.5	28.5	253.0	204.4	28.4	232.8	209.1	23.6	232.7	205.5	20.2	225.7
R. H. Robbins...	96.9	32.8	129.7	147.7	34.8	182.5	153.9	40.3	194.2	168.0	34.3	202.3	162.9	31.0	193.9
Average of all...	123.0	26.9	149.9	179.9	24.1	204.0	177.3	26.4	203.7	178.4	24.2	202.6	180.8	22.7	203.5
Av. increase yield				56.9		54.1	54.3		53.8	55.4		52.7	57.8		53.6

DISCUSSION OF RESULTS.

Those who read this bulletin should bear in mind that these yearly records of field experiments are really reports of progress. Anything in the nature of conclusions will scarcely be more than a statement of what is the outcome of a single year's observations. After several years general deductions will have greater value, especially if evidence is cumulative in particular directions.

EFFECT OF QUANTITY OF FERTILIZER UPON YIELD AND PROFIT.

In 1897 the application of 1,000 lbs. of fertilizers per acre proved to be more profitable than quanties either less or more, although in both years the yield has increased with the amount of fertilizer even up to 2,000 lbs. per acre. In 1898 the profit was greatest with 1,500 lbs. of fertilizer per acre, diminishing when more than this quantity was used. (See Tables V & VI). This lack of uniformity in results demonstrates the necessity of several years of observation before reliable conclusions can be drawn. Just what will happen after several rotations of crops have been grown is not yet clear.

TABLE V.— INCREASE OF YIELD OF POTATOES FROM DIFFERENT QUANTITIES OF FERTILIZER.

Number of plats averaged for both years.	Amount of fertilizer per acre.	Increase.* 1897.		Increase. 1898.		Average increase both years.	
		Large.	Total.	Large.	Total.	Large.	Total.
	Lbs.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
24	500	34.1	31.6	33.2	33.4	33.6	**32.5**
24	1,000	69.1	62.3	61.8	60.7	65.4	**61.5**
24	1,500	77.5	65.1	85.8	84.8	81.6	**75.0**
24	2,000	78.7	71.3	89.9	89.7	84.3	**80.5**

*Average of Fleet and Hallock plats.

TABLE VI.— FINANCIAL RESULTS.

Amount fertilizer per acre.	1897.				1898.				Bushel cost of potatoes from each 500 lbs. fert. added.	Bushel cost of potatoes from each 500 lbs. fert. added.
	Acre value total crop.*	Value of increase.	Cost of fertilizer.	Gain.	Acre value total crop.†	Value of increase.	Cost of fertilizer.	Gain.		
	$	$	$	$	$	$	$	$	$	$
None	54.20				41.60					
500 pounds	75.00	20.80	6.25	14.55	56.58	14.98	6.25	8.73	.20	.187
1,000 pounds	89.97	35.77	12.50	23.37	69.19	27.59	12.50	15.09	.20	.229
1,500 pounds	95.27	41.07	18.75	22.32	80.01	38.41	18.75	19.66	.223	.259
2,000 pounds	95.15	40.95	25	15.95	82.02	40.42	25	15.42	1.01	1.27

* Large potatoes at 75 cts. per. bushel and small at 25 cts.
† Large potatoes at 45 cts. per bushes and small at 20 cts.

THE RELATIVE EFFICIENCY OF THE POTATO FORMULA AND THE L. I. FORMULA.

The proportions of plant food in these formulas are quite different, the phosphoric acid being only one-half in the former that it is in the latter. In both seasons the L. I. Formula has returned the larger yields, the superiority in 1898 not being so evident as in 1897. (See Table VII.)

TABLE VII.— SUMMARY OF YIELDS OF POTATOES WITH "POTATO" FORMULA AND L. I. FORMULA.

Amount of fertilizer per acre.	1897.*			1898.		
	Potato formula.	L. I. formula.	Excess from L. I. formula.	Potato formula.	L. I. formula.	Excess from L I formula.
None	113.1			107.4		
500 lbs.	125.5	163.8	38.3	138.0	143.5	5.5
1,000 lbs.	166.2	184.7	18.5	167.7	168.4	0.7
1,500 lbs.	166.8	189.5	22.7	188.2	196.2	8.0
2,000 lbs.	178.4	190.4	12.0	191.7	202.6	10.9

THE INFLUENCE OF POTASH IN THE FERTILIZERS.

A popular notion widely prevails that potash manures are especially required by the potato crop. This view is probably based upon the fact that the potato plant takes more potash than some others grown agriculturally. Doubtless the marked effect of ashes in some instances has led to the belief that potash is often seriously deficient in ordinary soils, when as a matter of fact ashes modify fertility in ways not wholly attributable to the potash they contain.

It is widely noticeable that the most popular fertilizer mixture in use on Long Island contains more potash than nitrogen or phosphoric acid. This may be in accordance with the real demands of Long Island soils, but in view of the preponderant influence of phosphoric acid as often observed in so many localities, the economy of such an abundant use of potash is certainly open to question. Because of the doubt, it was decided to test the

* From Fleet and Hallock plats.

effect of varying quantities of this ingredient on the productiveness of the potato crop.

Four formulas were used on four acres of land, one on each of four farms. The percentages of nitrogen and phosphoric acid were the same in each formula, the proportion of potash being respectively 0 per cent, 3.5 per cent, 7.0 per cent and 10 per cent. On all fertilized plats the fertilizer was applied at the rate of 1,000 lbs. per acre, so that the amount of potash per acre varied from none to 100 lbs.

TABLE VIII.— RESULTS FROM POTASH TEST FORMULAS.

No. of plats averaged.	Plant food applied per acre.	Yield.		Gain.	
		Large.	Total.	Large.	Total.
		Bu.	Bu.	Bu.	Bu.
8	No fertilizer	123.0	149.9	....	....
8	40 lbs. nitrogen, 80 lbs. phos. acid and no potash	179.9	204.0	56.9	54.1
8	40 lbs. nitrogen, 80 lbs. phos. acid and 35 lbs. potash	177.3	203.7	54.3	53.8
8	40 lbs. nitrogen, 80 lbs. phos. acid and 70 lbs. potash	178.4	202.6	55.4	52.7
8	40 lbs. nitrogen, 80 lbs. phos. acid and 100 lbs. potash	180.8	203.5	57.8	53.6

Table VIII shows that the fertilizer without potash was as efficient as those containing this ingredient, and of course under these conditions the variation in the amount of potash was without influence. Such a result was a surprise, and emphasizes the need of further inquiry into the use of commercial plant-food.

II. SUGAR BEET INVESTIGATION IN 1898.*

L. L. Van Slyke.

SUMMARY.

I. COOPERATIVE EXPERIMENTS IN GROWING SUGAR BEETS.

Experiments were undertaken in cooperation with farmers in ten different counties to study the yield, composition and cost of sugar beets, with and without fertilizers. Seventeen different sets of results were reported.

(1) Yield. The yield of sugar beets, trimmed and washed, varied from 8,670 lbs. to 58,990 lbs. an acre and averaged 26,720 lbs.

(2) Percentage of sugar. The percentage of sugar in beets varied from 10.1 to 18.5 and averaged 15.5 per cent.

(3) Coefficient of purity varied from 72.5 to 87.3 and averaged 82.3.

(4) Size. The weight of beets analyzed varied from 5 to 27 and averaged 15.7 ozs.

(5) Cost of growing beets. The results presented show in many cases what beets cost when grown under favorable conditions. According to the results reported, the cost of growing one acre of sugar beets varied from $33.34 to $108.86 and averaged $59.87. This made the cost of one ton of sugar beets vary from $2.60 to $10 and average $4.50.

(6) Money value of crop. The amount of money that would be received for the beets grown on one acre according to factory prices without bounty would vary from $18.42 to $95.86 and would average $63.46.

* Reprint of Bulletin No. 155.

(7) Effect of fertilizers in growing sugar beets. A complete fertilizer was prepared and distributed by the Station and was used at the rate of 500 lbs. and 750 lbs. an acre.

(a) The application of fertilizer increased the yield in all but two cases. With 500 lbs. the crop increased an average of 3,874 lbs.; with 750 lbs., the yield increased 5,264 lbs. an acre.

(b) The application of 500 lbs. of fertilizer did not affect the average percentage of sugar in beets. With the larger application the sugar increased in 4 cases and decreased in 13 cases, the average decrease being 0.5 per cent.

(c) The coefficient of purity was affected little by fertilizers.

(d) The use of 500 lbs. of fertilizer increased cost of beets about $6 an acre; of 750 lbs., about $9 an acre. The use of 500 lbs. decreased the cost of beets 22 cents a ton, which was not farther decreased by increased amounts of fertilizer.

(e) The use of 500 lbs. of fertilizer an acre proved more economical than the use of larger amounts.

II. SUMMARY OF RESULTS OF ALL ANALYSES OF SUGAR BEETS MADE IN 1898.

The Station analyzed 343 samples of sugar beets which gave an average percentage of 14.2 of sugar, with a purity coefficient of 85. Results from 33 counties are given.

III. SPECIAL INVESTIGATIONS RELATING TO SUGAR BEETS.

Experiments were carried out on the Station farm and also on the farm of Mr. F. E. Dawley at Fayetteville to study (1) the effect of using different amounts of commercial fertilizers varying from 500 lbs. to 2,000 lbs.; (2) the effect of using 20 tons of stable manure per acre; and (3) the effect of growing beets at different distances in the row.

(1) The effect of using different quantities of commercial fertilizer is discussed under six headings:

(a) Increased yields of beets were given by applying 500 lbs., 1,000 lbs. and 1,500 lbs. of fertilizer, but the use of 2,000 lbs. gave less yield than did the use of 1,000 lbs.

(b) The percentage of sugar remained the same with 500 lbs., 1,000 lbs. and 1,500 lbs. of fertilizer, which was 1 per cent less than when beets were grown without fertilizer.

(c) The coefficient of purity was slightly decreased by the use of commercial fertilizers.

(d) The size of beets was increased.

(e) The use of 500 lbs. of fertilizer was attended with profit of nearly five dollars an acre, but the profit decreased when more was used. When 1,500 lbs. and more were used, there was an actual loss.

(f) The cost of growing one acre of sugar beets at Fayetteville was $28.20, not including cost of seed, fertilizer and marketing.

(2) The effect of stable manure upon yield and quality of beets was shown in the following ways:

(a) The yield was increased in every case, the average increase being 8,720 lbs. an acre.

(b) The percentage of sugar was increased an average of 1.5 per cent.

(c) The coefficient of purity was increased an average of 1.6.

(d) The size of beets was decreased an average of 2 3-4 ounces.

(e) The use of 20 tons of stable manure per acre furnishes very much more plant food than do 500 lbs. of the commercial fertilizer used, but it is not all available at once.

(3) In growing beets at different distances apart in the rows, the nearer the beets were in the row the smaller they grew in size, and the smaller yield they gave per acre.

I. COOPERATIVE EXPERIMENTS IN GROWING SUGAR BEETS.

INTRODUCTION.

In 1897 this Station undertook no experiments in the growing of sugar beets except those carried out on the Station farm. Some analyses of miscellaneous samples grown by various farmers in different parts of the State were made and published in Bulletin

No. 135, but the data obtained from such analyses possessed small value, owing to the fact that little was known about the detailed conditions under which the beets were grown.

It was decided to undertake during the season of 1898 a number of experiments in cooperation with carefully selected, representative farmers in several different counties. It has been the object of these cooperative experiments to study with care the following points:

(1) The yield, composition and cost of sugar beets grown in various parts of the State under known conditions.

(2) The effect of the use of commercial plant-foods upon the yield of beets, their composition, size, cost, etc.

We publish separately a summary of the analyses of a large number of samples of beets that have been sent us for analysis, about which we have little or no knowlege in regard to the conditions of growth.

The Station has carried on a special line of investigation on the Station farm, the detailed results of which will be presented and discussed by themselves.

The cooperative work was carried on at one or more places, in ten different counties as follows: Three places in Oneida county; two places each in Madison, Onondaga, Wayne and Cayuga counties; and one place in Oswego, Schuyler, Ontario, Seneca and Cortland counties. All the work is not reported here, because some crops were failures and some of those cooperating failed to carry out instructions in keeping records that could be used. The size of plats used varied from one-tenth to one-fifth of an acre. The beet seed and the fertilizer were furnished by the Station. Immediate direction of the work was exercised as far as possible through the personal supervision given by Mr. Geo. A. Smith on the part of the Station.

In making analysis of the beets, 20 or more beets were used in securing a sample, as the analysis of this number was found much

more nearly to represent the average than did the analysis of only two beets.

The results of our cooperative work will be presented in the following order:

I. Tabulated statement of general results.
II. Explanatory notes.
III. Yield of beets.
IV. Percentage of sugar in beets.
V. Coefficient of purity.
VI. Size of beets.
VII. Cost of growing sugar beets.
VIII. Money value of crop.
IX. Profit and loss in growing sugar beets.
X. The influence of fertilizers in growing sugar beets.

I. GENERAL RESULTS.

TABLE I.— STATEMENT OF GENERAL RESULTS.

Name and address of grower.	Fertilizer used per acre.	Beets trimmed and washed grown per acre.	Cost of beets per acre.	Cost of beets per ton.	Sugar in beets.	Coefficient of purity of juice.	Average weight of beets analyzed.
	Lbs.	Lbs.	$	$	Per ct.		Ounces.
1. L. R. Bridge	0	19,820	99.86	10.00	15.6	87.3	12
Solsville	500	22,130	105.86	9.56	15.6	86.1	12½
Madison Co.	750	26,535	108.86	8.22	14.8	86.2	12¾
2. Isaac J. Clark	0	30,400	45.14	2.97	13.8	81.5	14½
Waterville	500	26,695	51.14	3.84	14.4	82.2	18
Oneida Co.	750	28,050	54.14	3.86	15.2	83.2	19
3. Perry W. Clark ..	0	32,280	89.92	5.57	16.9	85.2	14½
Marcellus	500	33,000	95.92	5.80	15.0	82.2	17
Onondaga Co.	750	35,820	98.92	5.52	14.7	84.3	18
4. S. H. Davis	0	12,350	57.44	9.30	14.6	80.0	13
Cazenovia	500	16,530	63.44	7.67	16.0	84.2	12
Madison Co.	750	17,530	66.44	7.58	15.4	84.0	11
5. Walter Elden	0	14,440	45.40	6.29	17.2	82.4	23
Camden	500	18,060	51.40	5.70	15.7	80.5	27
Oneida Co.	750	16,230	54.40	6.70	15.7	80.8	22
6. Geo. P. Elliott ...	0	19,100	37.44	3.92	14.3	80.1	15
Central Square ...	500	17,430	43.44	5.00	14.7	79.2	15
Oswego Co.	750	19,810	46.44	4.69	13.6	78.1	20

TABLE I — *Continued.*

	Name and address of grower.	Fertilizer used per acre	Beets trimmed and washed grown per acre.	Cost of beets per acre.	Cost of beets per ton.	Sugar in beets.	Coefficient of purity of juice.	Average weight of beets analyzed.
		Lbs.	Lbs.	$	$	Per ct.		Ounces.
7.	W. F. Filkins	0	15,200	39.50	5.20	14.8	82.7	12
	Sodus	500	15,340	45.50	5.93	14.3	79.9	17½
	Wayne Co.	750	20,330	48.50	4.77	15.1	82.5	18
8.	Cyrus E. Fitch ...	0	14,190	37.20	5.24	17.1	84.5	10½
	Wolcott	500	22,380	43.20	3.86	16.9	86.0	15
	Wayne Co.	750	23,510	46.20	3.93	17.1	86.3	17
9.	A. H. Goodrich ...	0	19,110	52.26	5.47	17.6	85.0	12
	Oakwood	500	27,930	58.26	4.17	17.4	84.1	16
	Cayuga Co.	760	29,640	61.26	4.14	16.3	85.9	16
10.	Chas. W. Ingalls ..	0	52,920	72.96	2.76	10.1	72.5	19
	Watkins	500	55,820	78.96	2.83	10.8	73.4	19
	Schuyler Co.	750	58,990	81.96	2.79	11.4	75.6	17
11.	Chas. W. Ingalls ..	0	51,220	71.08	2.77	11.8	74.9	15
	Watkins	500	53,910	77.08	2.86	12.4	75.5	15
	Schuyler Co.	750	56,410	80.08	2.84	10.7	72.5	16
12.	W. S. Parrish ..	0	39,160	72.00	3.68	14.4	81.2	21½
	Canandaigua	500	40,010	78.00	3.90	15.3	82.4	19
	Ontario Co.	750	39,730	81.00	4.08	15.0	82.2	19
13.	Alfred Rapplye ..	0	25,430	33.34	2.62	16.4	80.1	16
	Farmer	500	31,290	39.34	2.60	15.4	81.6	21
	Seneca Co.	750	31,780	42.34	2.66	16.0	83.9	18½
14.	D. B. Satterly	0	16,640	58.56	7.04	14.7	81.9	13½
	Locke	500	———	———	———	15.8	84.4	14
	Cayuga Co.	750	25,640	67.56	5.27	14.5	86.6	18
15.	G. P. Squires & Son	0	8,670	39.20	9.05	13.8	85.6	11
	Marathon	500	13,000	45.20	7.00	14.3	85.6	14½
	Cortland Co.	750	13,540	48.20	7.10	13.3	82.9	12½
16.	L. G. Stook	0	15,740	34.42	3.88	15.6	85.4	15
	Verona	500	20,555	40.42	3.93	14.9	83.0	16
	Oneida Co.	750	21,475	43.42	4.04	14.1	84.3	16
17.	A. C. Toll	0	15,680	47.04	6.00	15.5	86.4	5
	Baldwinsville	500	26,690	53.04	3.98	14.9	85.5	8
	Onondaga Co.	750	26,930	56.04	4.16	13.8	85.5	8½

II. EXPLANATORY NOTES.

(1) L. R. Bridge. The high cost was due to the fact that the weeding was not done soon enough and this needlessly added to the cost over $20 an acre. The soil was previouly used for growing hops. The crop was healthy.

(2) Isaac J. Clark. Corn was grown on soil previous year. The crop was well cared for and was healthy.

(3) Perry W. Clark. The soil was rich, having been used previously for growing teazels. The crop was well cared for and free from disease.

(4) S. H. Davis. In some spaces there were no beets and the crop was somewhat affected by the hot, dry weather; hence, the low yield. The crop received good care and clean culture.

(5) Walter Elden. The land was stony and the soil firm. The culture was good. The low yield on the plat received 750 pounds fertilizer was due to the fact that the ground in this place was wet. Took out every other row on other plats. This accounts for large size of beets.

(6) Geo. P. Elliott. Soil occupied by corn previous year. Beet crop healthy, and well cared for, but there were many spaces not occupied by beets.

(7) W. F. Filkins. Soil was a peculiar sandy loam, occupied by oats previous year. The crop was healthy and received good care, but was not uniform.

(8) Cyrus E. Fitch. Soil was a good sandy loam, previously used for raspberries. The first sowing was a failure, owing to sowing too deep. The second sowing produced an uneven crop. The crop received excellent care.

(9) A. H. Goodrich. Soil was a sandy loam, previously occupied by corn. The first sowing on the unfertilized plat did not come up and a second sowing had to be made. The crop received good culture and was healthy.

(10) Chas. W. Ingalls. The soil was muck, previously used in growing cabbage, and had never been fertilized. Crop received good culture and was healthy. The soil was probably overrich in nitrogen and so produced beets with low sugar content and purity.

(11) Chas. W. Ingalls. The soil was alluvial clay, previously occupied by corn, and had never been fertilized. Crop received good culture, but was more or less blighted. The leaves dried

and then started to grow again, which probably accounts for the low sugar content and purity coefficient.

(12) W. S. Parrish. The soil was clay loam, occupied by corn previous year and manured previous fall with stable manure. Beet crop was healthy, well cared for and uniformly fine in appearance.

(13) Alfred Rapplye. The soil was clay loam, occupied by oats previous year and seeded. The crop received good culture, was healthy and uniform.

(14) D. B. Satterly. The soil was gravelly loam, previously used for potatoes. The crop started well and was then partially washed out in places by heavy rains. The plat which received 500 pounds fertilizer was ruined by being washed out.

(15) G. P. Squires & Son. The soil was clay loam, occupied by corn in previous year. Beets came up very unevenly. The crop received good culture and was healthy.

(16) L. G. Stock. The soil was a gravelly loam, used for potatoes preceding year. The stand of beets was fairly good, but the crop was affected by leaf spot.

(17) A. C. Toll. The soil was good, sandy loam, used for tobacco the previous year. The crop was healthy and the culture excellent.

III. YIELD OF BEETS.

The yield of beets, trimmed and washed, varied from 8,670 pounds to 58,990 pounds an acre and averaged 26,720 pounds. In several cases the low yield was due to an uneven stand of beets; in one case, to leaf spot; and in one case, to heavy rains. Under the conditions, taking all the results, we may regard the yield of over 13 tons of trimmed and washed beets per acre as a very good average.

IV. PERCENTAGE OF SUGAR IN BEETS.

The percentage of sugar in beets varied from 10.1 to 18.5 per cent and averaged 15.5 per cent. The lowest percentages were

given in one case by beets grown on muck soil, and in another case by beets that put out a second growth of leaves.

V. COEFFICIENT OF PURITY.

The "coefficient of purity" is the proportion or percentage which the sugar forms of the total solids in the juice. The non-sugar solids prevent crystallization of sugar to some extent. Therefore, the larger the amount of sugar in comparison with the other solids, the larger will be the proportion of sugar in the beet that will crystallize out and be obtained in manufacture. The higher the coefficient of purity, the more valuable the beet for economical sugar production. For a more detailed explanation, the reader is referred to Bulletin No. 135, pp. 556-557.

In the various beets examined in our cooperative work the coefficient of purity varied from 72.5 to 87.3 and averaged 82.3. The lowest degree of purity accompanied the lowest content of sugar and was due to the same causes.

VI. SIZE OF BEETS.

The weight of beets analyzed and varied from 5 to 27 ounces and averaged 15.7 ounces. Within these limits, the increase of size did not apparently exercise any marked or definite influence upon either the percentage or purity of sugar.

VII. THE COST OF GROWING SUGAR BEETS.

Each farmer cooperating in the work was furnished with necessary blanks and was requested to keep an accurate account of all labor of different kinds expended upon the plats of sugar beets and also to state the value of the labor. In all cases except one this was done, the total labor cost alone without items being reported in this single instance.

In considering the results presented below, the following statements should be kept in mind:

(1) The amount, kind and cost of labor employed differed very widely, as reported by different experimenters.

(2) The highest reported cost was due to neglect in not weeding the beets in time. This ought to afford a good object lesson as to the necessity of prompt and sufficient culture of the crop.

(3) In most cases, the work was carried on with whatever appliances happened to be on hand and in few cases was any special form of machine or tool used to save hand labor.

(4) The cost of growing beets on quarter-acre plats is necessarily more expensive in proportion than in case of beets grown on a commercial scale. The larger the acreage, the smaller should be the cost per acre.

(5) If farmers were to charge against any farm crop in the same detailed way the various items of cost in growing, the results would undoubtedly show quite as much to their disadvantage as to that of sugar beets.

(6) While the figures presented below are of service in showing what the cost of sugar beets may be when the work is carried on without special appliances and without previous experience, and while they show what this crop is apt to cost farmers when they first undertake to grow it, the figures do not represent the cost of sugar beets grown under favorable conditions, where labor-saving appliances are used and where the grower has acquired experience in growing beets most economically and intelligently.

According to the returns made by those raising beets, it may be seen that the cost of growing one acre of sugar beets varied from \$33.34 to \$108.86 and averaged \$59.87. This made the cost of one ton of sugar beets, trimmed and washed, vary from \$2.60 to \$10 and average \$4.50. A careful analysis of the detailed data upon which these results are based shows that the amount and cost of labor varied greatly with different individuals.

(1) The number of hours of team labor employed per acre varied from 5 to 44 and averaged 30½. The estimated cost of team labor per hour varied from 15 to 30 cents and averaged 23¼ cents. The total cost of team labor employed varied from \$2 to \$13.40 an acre and averaged \$7.

(2) In 8 cases the use of one horse is reported, varying in time from 6½ to 70 hours an acre and averaging 21 hours, the estimated cost of which varied from 7½ to 12½ cents an hour and averaged 10½. The total cost for use of single horse varied from $0.60 to $7 and averaged $2.20 an acre.

(3) The number of hours of hand labor reported varied from 250 to 852 hours an acre and averaged 400 hours. The price of hand labor varied from 3 cents to 12½ cents an hour and averaged 10¾ cents. The total cost of hand labor varied from $25 to $92.06 and averaged $43.40.

(4) The total cost of all kinds of labor employed varied from $33.34 to $108.86 and averaged $59.87 an acre.

VIII. MONEY VALUE OF CROP.

The amount of money has been calculated that would be received from an acre of beets, trimmed and washed, delivered at the factory, allowing $4 a ton for beets containing 12 per cent of sugar and having a purity coefficient of 79, and 25 cents a ton, more or less, for each per cent of sugar above or below 12. The amount of money thus received would vary from $18.42 to $95.86 and would average $63.46.

IX. PROFIT AND LOSS IN GROWING SUGAR BEETS.

In 26 cases the amount of money received from beets exceeded the cost of growing the crop by amounts varying from $1.19 to $37.11 an acre. In 25 cases there was a loss varying from 5 cents to $53.30 an acre. Averaging all the work done by the different experimenters on the different plats, the receipts exceeded the cost of growing the crop $4.04 an acre. In this connection the statements made above under cost of growing sugar beets must be kept in mind.

X. THE INFLUENCE OF FERTILIZERS IN GROWING SUGAR BEETS.

A fertilizer containing the following constituents was distributed among those taking part in the cooperative work: 1,000 pounds

of acid rock, 350 pounds of sulphate of potash, 450 pounds of dried blood, 200 pounds of nitrate of soda. This mixture was applied at the rates of 500 pounds and 750 pounds an acre. The approximate cost of this mixture was $24 a ton, which would make the cost of the fertilizer applied equal to $6 in one case and $9 in the other.

(1) *Effect of fertilizers on yield.*— When 500 pounds of fertilitilizer per acre were applied, the yield of beets, trimmed and washed, increased in 15 out of 17 cases. The increase of yield varied from 140 pounds to 9,010 pounds an acre. The average increase in all cases amounted to 3,874 pounds an acre.

The application of 750 pounds of fertilizer was accompanied by an increased yield in every case but one, as compared with the use of no fertilizer. The increase of yield varied from 570 pounds to 11,790 pounds and averaged 5,264 pounds an acre.

As compared with the application of 500 pounds of fertilizer an acre, the application of 750 pounds was attended by an increase except in two cases. The increased yield varied from 240 pounds to 8,170 pounds and averaged 1,390 pounds an acre.

TABLE II.— EFFECT OF FERTILIZERS ON YIELD OF BEETS PER ACRE.

Fertilizer used.	Lowest yield.	Highest yield.	Average yield.
Lbs.	Lbs.	Lbs.	Lbs.
0	8,670	52,920	23,674
500	13,000	55,820	27,548
750	13,540	58,990	28,938

(2) *Effect of fertilizers on percentage of sugar.*— When 500 pounds of fertilizer an acre were applied, the sugar content of the beets increased in 9 cases and decreased in 8 cases, the general average remaining unchanged. With the application of 750 pounds an acre, the sugar increased in 4 cases and decreased in 13 cases, the average decrease being one-half of 1 per cent.

TABLE III.— EFFECT OF FERTILIZERS ON PERCENTAGE OF SUGAR IN BEETS.

Fertilizer used per acre.	Amount of sugar in beets.		
	Lowest.	Highest.	Average.
Lbs.	Per ct.	Per ct.	Per ct.
0	10.1	18.5	15.7
500	10.8	18.3	15.7
750	10.7	18.0	15.2

(3) *Effect of fertilizers on coefficient of purity.*— When 500 pounds of fertilizer an acre were used, the coefficient of purity increased in 8 acres and decreased in 9 cases, there being an average decrease of one-tenth. With 750 pounds of fertilizer, the coefficient of purity increased in 8 cases and decreased in 9 cases, there being an average increase of four-tenths.

TABLE IV.— EFFECT OF FERTILIZERS ON COEFFICIENT OF PURITY.

Fertilizer used per acre.	Coefficient of purity.		
	Lowest.	Highest.	Average.
Lbs.			
0	72.5	87.3	82.2
500	73.4	86.1	82.1
750	72.5	86.6	82.6

The cost of beets per ton was increased in 8 cases and decreased in 9 cases by the use of 500 pounds of fertilizer, there being an average decrease amounting to 22 cents a ton. The use of 750 pounds of fertilizer increased the cost in 8 cases and decreased it in 9 cases, the average cost being about the same as with 500 pounds.

TABLE V.— EFFECT OF FERTILIZERS ON COST OF BEETS PER ACRE.

Fertilizer used per acre.	Cost of beets.		
	Lowest.	Highest.	Average.
Lbs.			
0	$33 34	$99 86	$54 87
500	39 34	105 86	60 87
750	42 34	108 86	63 87

(4) *Effect of fertilizers on cost of beets.*— The use of 500 pounds of fertilizer increased the cost of beets about $6 an acre; and the use of 750 pounds, about $9.

TABLE VI.— EFFECT OF FERTILIZERS ON TONNAGE COST OF BEETS.

Fertilizer used per acre.	Tonnage cost.		
	Lowest.	Highest.	Average.
Lbs.			
0	$2 62	$10 00	$4 64
500	2 60	9 56	4 42
750	2 66	8 22	4 41

(5) *Effect of fertilizers on money value of crop.*— With the use of 500 pounds of fertilizer the money value of the crop increased in 14 out of 17 cases, the increase varying from 32 cents to $23.15 an acre and averaging $7.26. The use of 750 pounds, as compared with 500 pounds of fertilizer, increased the money value of the crop in 11 out of 17 cases, the amount of increase varying from 30 cents to $13.76 and averaging $2.61. The use of 750 pounds of fertilizer, as compared with no fertilizer, increased the value of the crop in 15 out of 17 cases, the increase varying from 65 cents to $23.94 and averaging $9.87.

The use of 500 pounds of fertilizer increased the average value of the crop enough to pay for the fertilizer used and leave $1.26 over. The use of 750 pounds of fertilizer increased the average value of the crop $9.87 or enough to pay for the fertilizer used and 87 cents more. Hence, the use of 750 pounds of fertilizer was attended with less profit than the use of 500 pounds.

TABLE VII.— EFFECT OF FERTILIZERS ON MONEY VALUE OF CROP.

Fertilizer used per acre.	Value of beets per acre.		
	Lowest.	Highest.	Average.
Lbs.			
0	$18 42	$83 23	$44 39
500	29 25	94 34	51 65
750	28 77	95 86	54 26

II. SUMMARY OF RESULTS OF ALL ANALYSES OF SUGAR BEETS MADE DURING THE SEASON OF 1898.

There were analyzed at this Station, during the fall of 1898, 243 samples of sugar beets. The average percentage of sugar in the beets is 14.2, with a coefficient of purity of 85.

The results are given by counties, thirty-three of which are represented.

TABLE VIII.—COMPOSITION OF SUGAR BEETS GROWN IN 1898.

County.	No. of samples.		Sugar in beet.	Sugar in juice.	Coefficient of purity of juice.	Weight of one beet.
			Per ct.	Per ct.		Ozs.
Albany	9	Lowest...	11.9	12.5	79.2	6
		Highest...	16.3	17.2	83.3	24
		Average..	13.8	14.5	80.7	16
Allegany	1	....	15.3	16.1	83.9	18
Cayuga	15	Lowest...	12.5	13.2	78.4	9
		Highest...	17.6	18.5	88.8	31
		Average..	15.2	16.0	84.8	17
Chautauqua	9	Lowest...	11.8	12.4	79.8	11
		Highest...	16.0	16.8	85.7	30
		Average..	14.1	14.8	83.0	17
Chemung	1	....	16.1	16.9	82.0	30
Chenango	4	Lowest...	11.0	11.6	77.3	12
		Highest...	14.2	14.9	83.5	16
		Average..	12.9	13.6	81.6	13
Columbia	3	Lowest...	7.4	7.8	64.1	7
		Highest...	15.0	15.8	83.8	14
		Average..	12.0	12.6	77.0	10
Cortland	7	Lowest...	13.0	13.7	78.5	10
		Highest...	14.3	15.1	85.6	16
		Average..	13.4	14.1	83.1	13

TABLE VIII — *Continued.*

County.	No. of samples.		Sugar in beet.	Sugar in juice.	Coefficient of purity of juice.	Weight of one beet.
			Per ct	Per ct.		Ozs.
Dutchess	1	....	9.4	9.9	70.1	20
Greene	2	Lowest...	12.0	12.6	75.0	17
		Highest...	16.1	16.9	81.7	23
		Average..	14.1	14.8	78.3	20
Herkimer	4	Lowest...	11.1	11.7	80.6	7
		Highest...	17.4	18.3	86.0	25
		Average..	14.1	14.8	83.8	15
Jefferson	54	Lowest...	8.5	8.9	69.5	8
		Highest...	19.0	20.0	89.0	32
		Average..	13.6	14.3	83.5	20
Lewis	13	Lowest...	10.4	11.0	73.7	8
		Highest...	15.0	15.8	87.7	23
		Average..	13.3	14.0	80.4	17
Madison	9	Lowest...	14.3	15.	84.1	12
		Highest...	15.6	16.4	90.0	21
		Average..	15.0	15.8	86.3	15
Monroe	1	....	12.8	13.5	80.1	23
Montgomery	3	Lowest...	13.2	13.9	79.1	27
		Highest...	14.2	14.9	81.4	33
		Average..	12.6	14.3	80.3	30
Oneida	18	Lowest...	12.8	14.5	80.3	14
		Highest...	17.1	18.0	89.1	24
		Average..	15.4	16.2	84.3	19
Onondaga	36	Lowest...	11.4	12.0	76.7	4
		Highest...	19.6	20.6	87.7	31
		Average..	15.0	15.8	82.4	14
Ontario	58	Lowest...	10.4	10.9	77.4	10
		Highest...	18.5	19.5	89.8	31
		Average..	14.7	15.5	84.1	17

TABLE VIII — *Continued.*

County.	No. of samples.		Sugar in beet.	Sugar in juice.	Coefficient of purity of juice.	Weight of one beet.
			Per ct.	Per ct.		Ozs.
Oswego	6	Lowest...	12.7	13.4	77.6	15
		Highest...	14.8	15.6	82.5	24
		Average..	14.0	14.7	79.7	20
Otsego	5	Lowest...	13.5	14.2	82.2	12
		Highest...	16.9	17.8	84.9	18
		Average..	15.0	15.8	83.4	15
Schenectady	4	Lowest...	11.3	11.9	81.3	20
		Highest...	13.3	14.0	86.4	22
		Average..	12.5	13.2	83.8	21
Schoharie	12	Lowest...	11.6	12.2	78.3	11
		Highest...	20.2	21.2	85.8	54
		Average..	15.9	16.7	82.5	19
Schuyler	14	Lowest...	9.5	10.	72.5	13
		Highest...	12.8	13.5	78.6	20
		Average..	11.2	11.8	75.6	17
Seneca	6	Lowest...	14.7	15.5	80.1	16
		Highest...	16.4	17.3	87.1	23
		Average..	15.4	16.2	84.0	21
St. Lawrence	2	Lowest...	15.6	16.4	85.1	11
		Highest...	16.4	17.3	86.6	12
		Average..	16.1	16.9	85.9	11
Suffolk	2	Lowest...	13.2	13.9	87.4	19
		Highest...	14.3	15.0	89.7	21
		Average..	13.8	14.5	88.5	20
Tioga	1	....	12.6	13.3	82.7	32
Ulster	4	Lowest...	14.6	15.4	80.1	9
		Highest...	15.2	16.0	85.4	13
		Average..	14.9	15.7	83.1	11
Washington	5	Lowest...	14.3	15.0	85.4	17
		Highest...	16.2	17.0	86.9	19
		Average..	14.8	15.6	86.2	18

TABLE VIII — *Concluded.*

County.	No of samples		Sugar in beet.	Sugar in juice.	Coefficient of purity of juice.	Weight of one beet.
			Pe ct.	Per ct.		
Wayne	24	Lowest...	11.6	12.2	79.9	8
		Highest...	17.3	18.2	89.3	24
		Average..	14.7	15.5	84.7	16
Wyoming	5	Lowest...	12.3	12.9	80.0	11
		Highest...	17.1	18.0	86.0	20
		Average..	14.1	14.8	84.0	17
Yates	6	Lowest...	13.4	14.1	82.2	9
		Highest...	16.2	17.0	87.0	17
		Average..	15.0	15.8	84.5	13
Total of season's results	343	Lowest...	7.4	7.8	64.1	4
		Highest...	20.2	21.2	90.0	54
		Average..	14.2	15.0	85.2	17

III. SPECIAL INVESTIGATIONS RELATING TO SUGAR BEETS.

A series of experiments was planned to be carried out on the Station farm for testing certain questions relating to sugar beets, and the cooperation of Mr. F. E. Dawley was secured in duplicating the work on his farm at Fayetteville. These experiments were designed to study the following points:

(1) Effect of different quantities of commercial plant-foods upon yield and quality of sugar beets.

(2) Effect of stable manure upon the yield and quality of sugar beets.

(3) Effect of growing sugar beets at different distances apart in the row upon their yield and quality.

In addition to this work, the Station raised beets from special varieties of seeds at the request of, and in cooperation with, Dr. H. W. Wiley, Chief of Division of Chemistry, United States Department of Agriculture.

I. EFFECT OF DIFFERENT QUANTITIES OF COMMERCIAL PLANT-FOODS UPON YIELDS AND QUALITY OF SUGAR BEETS.

The plats used in the experiments occupied about one-twelfth of an acre at the Station and about one-sixteenth of an acre at Mr. Dawley's farm. All figures given in the tables, and all discussions are based upon the results calculated to one acre.

The following mixture of plant-food materials was employed in these experiments: Two hundred pounds of nitrate of soda, 200 pounds of dried blood, 450 pounds of acid rock, and 150 pounds of sulphate of potash. This was applied at the rate of 500 pounds, 1,000 pounds, 1,500 pounds, and 2,000 pounds an acre at the Station and in the same quantities, except that of 2,000 pounds, at Fayetteville. In each place two sets of experiments were carried on.

TABLE IX.— RESULTS OF APPLYING COMMERCIAL FERTILIZERS IN GROWING SUGAR BEETS.

Amount of fertilizer used.	Yield of trimmed and washed beets per acre.	Sugar in beets.	Coefficient of purity of juice.	Average weight of beets analyzed.	Place of experiment.
Lbs.	Lbs.	Per ct.		Ozs.	
0	20,425	15.2	85.2	16½	Station.
500	21,375	15.6	85.7	16½	Station.
500	27,140	14.5	86.0	15	Station.
1,000	26,928	14.4	83.6	20	Station.
1,000	26,250	14.7	85.4	16	Station.
1,500	23,822	14.3	84.5	17	Station.
1,500	27,920	14.9	85.8	15½	Station.
2,000	22,073	15.0	85.6	16½	Station.
2,000	27,875	17.0	87.1	13½	Station.
0	18,585	15.4	81.6	12½	Fayetteville.
0	17,740	17.2	85.0	9	Fayetteville.
500	23,373	15.2	77.1	14½	Fayetteville.
500	24,075	14.3	79.8	16½	Fayetteville.
1,000	24,220	14.5	78.3	13½	Fayetteville.
1,000	24,220	15.9	81.3	10	Fayetteville.
1,500	26,890	15.3	80.1	18½	Fayetteville.
1,500	26,330	15.2	79.7	13½	Fayetteville.

(1) *Effect of fertilizers on yield.*— The use of commercial fertilizer increased the yield of beets in every instance. In the Station experiments, it is noticeable that the same amount of fertilizer on different plats gave widely varying results. Thus, with 500 pounds of fertilizer, we obtained in one case 21,375 pounds of beets and in the other case over 27,000 pounds. In the Fayetteville work, the agreement in results on duplicate plats was much closer. In the Station work the highest average yield from duplicate plats was given when 1,000 pounds of fertilizer were used. In the Fayetteville work the largest yield was given with 1,500 pounds of fertilizer, the yield increasing with increased application of fertilizer.

Averaging all the results, we can make the following statements:

(a) When 500 pounds of fertilizer per acre were used, the increased yield of beets, trimmed and washed, varied from 950 pounds to 6,715 pounds and averaged 4,700 pounds.

(b) When 1,000 pounds of fertilizer per acre were used, the increased yield of beets, as compared with the use of no fertilizer, varied from 5,825 pounds to 6,500 pounds and averaged 6,110 pounds. As compared with the yield obtained by use of 500 pounds of fertilizer, the use of 1,000 pounds gave an average increase of 1,400 pounds.

(c) When 1,500 pounds of fertilizer were used, the increased yield of beets, as compared with the use of no fertilizer, varied from 3,400 pounds to 8,730 pounds and averaged 6,950 pounds. As compared with 500 pounds of fertilizer, there was an increased yield of 2,250 pounds; and as compared with 1,000 pounds of fertilizer, an increased yield of 835 pounds.

(d) When 2,000 pounds of fertilizer were used, the increased yield of beets varied from 1,648 pounds to 7,450 pounds and averaged 5,680 pounds. The increased yield of beets was about 1,000 pounds more than when 500 pounds of fertilizer were used; but

the use of 2,000 pounds of fertilizer gave a smaller actual yield of beets than did the use of 1,000 pounds and 1,500 pounds of fertilizer. It is possible that the use of so large quantities of fertilizer may have affected the seed.

TABULATED SUMMARY SHOWING EFFECT OF FERTILIZERS ON YIELD OF BEETS.

Fertilizer used per acre.	Number of experiments.	Yield per acre.			
		Lowest.	Highest.	Average.	Increased average.
Lbs.		Lbs.	Lbs.	Lbs.	Lbs.
0	3	17,740	20,425	19,294	....
500	4	21,375	27,140	23,990	4,696
1,000	4	24,220	26,928	25,405	6,111
1,500	4	23,822	27,920	26,240	6,946
2,000	2	22,073	27,875	24,974	5,680

(2) *Effect of fertilizers on percentage of sugar.*— The general effect of applying fertilizers was to decrease slightly the percentage of sugar in beets. As between the application of 500 pounds, 1,000 pounds and 1,500 pounds of fertilizer, the average percentage of sugar remained the same. With 2,000 pounds there was an increased percentage of sugar.

TABULATED SUMMARY SHOWING EFFECT OF FERTILIZERS UPON PERCENTAGE OF SUGAR IN BEETS.

Fertilizer used per acre.	Number of experiments.	Amount of sugar in beets.		
		Lowest.	Highest.	Average.
Lbs.		Per ct.	Per ct.	Per ct.
0	3	15.2	17.2	15.9
500	4	14.3	15.6	14.9
1,000	4	14.4	15.9	14.9
1,500	4	14.3	15.3	14.9
2,000	2	15.0	17.0	16.0

(3) *Effect of fertilizers on coefficient of purity.*— The influence of fertilizers upon the coefficient of purity showed a slight decrease up to and including 1,500 pounds of fertilizer. The use of 2,000 pounds was attended with an increase in the coefficient

of purity. In the Station experiments the coefficient of purity was little affected; in the Fayetteville experiments, the coefficient of purity was lowered by using fertilizers.

TABULATED SUMMARY SHOWING EFFECT OF FERTILIZERS UPON COEFFICIENT OF PURITY.

Fertilizer used per acre.	Number of experiments.	Coefficient of purity.		
		Lowest.	Highest.	Average.
Lbs.				
0	3	81.6	85.2	83.9
500	4	77.1	86.0	82.1
1,000	4	78.3	85.4	82.1
1,500	4	79.7	85.8	82.5
2,000	2	85.6	87.1	86.3

(4) *Effect of fertilizers on cost of crop.*— The use of 500 pounds of fertilizer increased the cost of beets $6.50 an acre; 1,000 pounds, $13 an acre; 1,500 pounds, $19.50 an acre; and 2,000 pounds, $26 an acre.

(5) *Effect of fertilizers upon money value of crop.*— Averaging our results we find that the use of 500 pounds of commercial fertilizer increased the yield of beets enough to pay for the fertilizer used and leave $4.65 over. With larger amounts of fertilizer there was less profit, and above 1,000 pounds there was an actual loss.

TABULATED SUMMARY SHOWING EFFECT OF FERTILIZERS UPON MONEY VALUE OF CROP.

Fertilizer used per acre.	Value of beets per acre.				
	Lowest.	Highest.	Average.	Increase.	Profit from use of fertilizer.
Lbs.					
0	$42 13	$48 50	$45 82	....	....
500	50 76	64 46	56 98	$11 16	$4 66
1,000	57 52	63 95	60 33	14 51	1 51
1,500	56 58	66 31	62 32	16 50	*3 00
2,000	52 42	66 20	59 31	13 49	*12 51

* Loss.

(6) *Cost of growing sugar beets.*— Mr. Dawley reports the cost of growing one acre of sugar beets as $28.20, not including cost of fertilizer. His items are as follows:

Fitting ground	$5 20
Planting	1 75
Applying fertilizer	1 00
Ten times over with weeder	4 50
Thinning	5 25
One hoeing	3 00
Digging and topping	7 50
	$28 20
Drawing to railroad	4 50
Total	$32 70

[The cost of 500 lbs. of fertilizer would increase the cost to $34.70 or, including delivery at railroad, $39.20.]

II. EFFECT OF STABLE MANURE UPON THE YIELD AND QUALITY OF SUGAR BEETS.

This work was carried on at the Station and in duplicate at Fayetteville. Stable manure was applied at the rate of 20 tons an acre. The different amounts of plant-food applied in this form would approximately equal 200 pounds of nitrogen, 100 pounds of phosphoric acid and 200 pounds of potash.

The stable manure was applied to the land in the spring. This method is commonly reported to increase the size of the beets at the expense of the percentage of sugar and purity coefficient. But in the work done both at the Station and at Fayetteville, the very opposite effects were found.

Table X.— Results of Applying Stable Manure in Growing Sugar Beets.

Amount of stable manure applied per acre.	Yield of trimmed and washed beets.	Sugar in beets.	Coefficient of purity of juice.	Average weight of beets analyzed.	Distance between beets in row.	Place of experiment.
	Lbs.	Per ct.		Ozs.	Ins.	
0	20,425	15.2	85.2	16½	8	Station.
20 tons	25,360	18.5	85.2	12	6	Station.
20 tons	29,340	17.2	86.2	13	8	Station.
20 tons	28,690	16.4	86.7	15	10	Station.
20 tons	27,100	15.7	85.2	11	6	Station.
20 tons	28,354	16.2	85.7	12½	8	Station.
20 tons	28,630	17.2	87.4	13	10	Station.
20 tons	29,656	17.8	86.4	11	6	Station.
20 tons	29,533	17.9	87.7	14	8	Station.
20 tons	31,944	17.7	87.8	12	10	Station.
0	16,050	14.4	77.8	13½	8	Fayetteville.
0	18,022	15.5	82.0	16	8	Fayetteville.
20 tons	23,514	18.2	81.3	8½	8	Fayetteville.
20 tons	25,625	15.7	78.8	11½	8	Fayetteville.
20 tons	24,780	13.1	78.0	14½	8	Fayetteville.
20 tons	25,485	14.3	79.0	11½	8	Fayetteville.
20 tons	27,034	15.2	80.3	15½	8	Fayetteville.
20 tons	26,750	17.9	87.5	12½	8	Fayetteville.

(1) *Effect of stable manure upon the yield of beets.*— At the Station the application of 20 tons of stable manure per acre increased the yield 4,935 pounds to 11,520 pounds with an average increase of 8,310 pounds. At Fayetteville, the stable manure increased the yield of beets 6,480 to 10,000 pounds an acre with an average increase of 8,495 pounds. Taking an average of all the results, the yield increased 4,784 pounds to 13,214 pounds per acre, the average increase being 8,723 pounds.

Tabulated Summary Showing Effect of Stable Manure on Yield of Beets.

Amount of stable manure used per acre.	Number of experiments.	Yield per acre.			
		Lowest.	Highest.	Average.	Increased average.
		Lbs.	Lbs	Lbs.	Lbs.
0	3	16,050	20,425	18,730	....
20 tons	15	23,514	31,944	27,450	8,720

(2) *Effect of stable manure on percentage of sugar in beets.*— At the Station the percentage of sugar was increased 0.5 to 3.2 per cent with an average increase of 2 per cent. At Fayetteville the use of stable manure increased the percentage of sugar in four cases and decreased it in two cases, there being an average increase of 0.7 per cent. Taking all the work at both places, there was an average increase of 1.5 per cent of sugar.

TABULATED SUMMARY SHOWING EFFECT OF STABLE MANURE ON PERCENTAGE OF SUGAR IN BEETS.

Amount of stable manure used per acre.	Number of experi-ments.	Amount of sugar in beets. Lowest.	Highest.	Average.
		Per ct.	Per ct.	Per ct.
0	3	14.4	15.5	15.1
20 tons	15	13.1	18.5	16.6

(3) *Effect of stable manure on coefficient of purity.*— In the Station experiments the coefficient of purity increased in every case except one when stable manure was used, the increase varying 0 to 2.6 and averaging 1.3. At Fayetteville, the coefficient of purity increased in three cases and decreased in three cases, there being an average increase of 0.9. Taking the work in both places, there was an average increase of 1.6.

TABULATED SUMMARY SHOWING EFFECT OF STABLE MANURE UPON COEFFICIENT OF PURITY.

Amount of stable manure used per acre.	Coefficient of purity. Lowest.	Highest.	Average.
0	77.8	85.2	82.6
20 tons	78.0	87.8	84.2

(4) *Effect of stable manure on cost of crop.*— It would be a conservative estimate to place the cost of stable manure at $2 a ton, including costs of drawing to field and applying. The application of 20 tons would, therefore, cost $40 an acre.

(5) *Effect of stable manure upon money value of crop.*— The use of 20 tons of stable manure per acre increased the money value of the crops $12 to $33.03, with an average increase of $21.80. In no instance was the increase of crop equal to the cost of manure applied. In this connection, however, ought to be considered the fact that the plant-food in the stable manure would not be completely used in one season. If its effects were continued through two or three seasons, there would be some profit from its use.

III. COMPARISON OF COMMERCIAL FERTILIZERS AND STABLE MANURE IN THE GROWING OF SUGAR BEETS.

It will be a matter of interest to consider briefly side by side some of the average results obtained in growing beets with the use of commercial fertilizers and stable manure. For this purpose we will use only the results obtained with 500 pounds of commercial fertilizer.

AMOUNTS OF PLANT-FOOD APPLIED IN THE COMMERCIAL FERTILIZER AND IN THE STABLE MANURE USED.

	In 500 pounds commercial fertilizer.	In 200 tons stable manure.
	Lbs.	Lbs.
Nitrogen	21	200
Phosphoric acid	36	100
Potash	38	200

It will be seen that the stable manure applied to one acre contained about ten times as much nitrogen, three times as much phosphoric acid, and five times as much potash, as did the 500 pounds of commercial fertilizer used. It is safe to assume that one-third of the stable manure was available for the crop's use, which would furnish the crop three times as much nitrogen, the same amount of phosphoric acid, and twice as much potash as was furnished by 500 pounds of the commercial fertilizer.

TABULATED STATEMENT SHOWING SUMMARY OF COMPARISON OF RESULTS OBTAINED WITH STABLE MANURE AND COMMERCIAL FERTILIZERS.

Fertilizer used per acre.	Yield of beets per acre.	Sugar in beets.	Coefficient of purity.
	Lbs,	Per ct.	
None	18,060	15.5	82.3
500 lbs. commercial fertilizer	23,990	14.9	82.1
20 tons stable manure	27,450	16.6	84.2

IV. EFFECT OF GROWING BEETS AT DIFFERENT DISTANCES APART IN THE ROW.

The Station carried on three parallel sets of experiments to study the effect of growing beets at different distances apart in the row. The detailed data are given in the table on page 369. We summarize these results as follows:

TABULATED SUMMARY SHOWING EFFECT OF GROWING BEETS AT DIFFERENT DISTANCES APART IN ROW.

Distance between beets in rows.	Yield of beets per acre.	Sugar in beets.	Coefficient of purity of juice.	Average weight of beets analyzed.
Inches.	Lbs.	Per ct.		Ozs.
6	27,372	17.3	85.6	11¼
8	29,076	17.1	86.5	13
10	29,756	17.1	87.3	13¼

With increase in distance between beets in the row we notice an increase in yield, coefficient of purity and size of beets, with little change in the percentage of sugar.

V. TEST OF DIFFERENT VARIETIES OF SUGAR BEETS.

The United States Department of Agriculture furnished the Station with several varieties of beet seed with the request that

these be grown on the Station farm. The results are given in the table below:

TABLE XI.— RESULTS OBTAINED AT STATION FARM IN GROWING DIFFERENT VARIETIES OF SUGAR BEETS.

Name of variety.	Sugar in beets.	Coefficient of purity of juice.	Average weight of beets.	Yield of trimmed and washed beets per acre.
	Per ct.		Ozs.	Lbs.
Kleinwanzlebener (Baumeier's)	14.5	83.0	20½	24,620
Kleinwanzlebener (Schlitte Co.)....	13.8	79.7	17	23,890
Kleinwanzlebener (Vilmorin)	11.6	81.5	17½	42,486
Kleinwanzlebener* (Rice)	12.7	81.9	16	27,190
Pitzschke's Elite	14.2	84.1	19½	43,736
Vilmorin's French Very Rich.......	14.7	84.6	19	27,120
Vilmorin's Improved (Schlitte Co.)..	14.7	83.7	16	26,136
Vilmorin's White (Russian grown)..	12.0	79.8	17½	22,050
Zeringen (Strandes)	14.3	81.2	16	25,256

* American grown seed from Jerome B. Rice, Cambridge, N. Y.

REPORT

OF THE

HORTICULTURAL DEPARTMENT.

S. A. BEACH, M. S., *Horticulturist.*

WENDELL PADDOCK, B. S., *First Assistant.*

C. P. CLOSE, B. S., *Assistant.*

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REPORT OF THE HORTICULTURIST.

I. A COMPARISON OF SOIL MIXTURES FOR FORCING HEAD LETTUCE.*

S. A. Beach.

SUMMARY.

Tests of different soil mixtures for forcing head lettuce have been continued for three winters. A medium clay loam with various proportions of stable manure and sand, pure sand with manure, and a very light sandy loam with manure have been tried.

The clay loam with a heavy application of stable manure gave the best results.

The light sandy loam with heavy application of stable manure was least satisfactory.

On pure sand with a good dressing of stable manure the lettuce made a vigorous growth, but the heads were less firm and the texture more delicate than with the lettuce which was grown on the clay loam.

INTRODUCTION.

Some investigations were begun at this Station in the autumn of 1895 for the purpose of observing the influence of different soil mixtures on the earliness, texture, shape and size of lettuce grown under glass. The tests have been continued for three winters and four crops have been grown.

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A soil mixture which had been used for forcing lettuce with good results, composed of 3 parts rotted sod from a clay loam, 1 part sand and 1 part stable manure, was at first compared with the other mixtures which were made from it by adding different amounts of sand. In some later tests the amount of sand was still further varied or omitted entirely. In one case sand and stable manure alone were used without any loam. In another case a very light sandy loam was compared with the clay loam as a basis for the soil mixtures. Commercial fertilizers were also tried on some of the soils, both in combination with stable manure and alone.

DESCRIPTION OF FORCING HOUSE.

The experiments were conducted in an even-span, iron-frame structure 20 feet by 44 feet with sash bars 14 inches apart. The house extends east and west and has sash ventilators along the entire length of each side under the eaves and on either side of the ridge.

With Crop I the benches were 6 inches deep, outside measurement; with Crops II, III and IV they were 12 inches deep. Crops I, II and III were watered entirely on the surface. Crop IV was principally subwatered through tile lying on the cemented bottom of the bench.

The house is heated by 2 hot-water coils of $3\frac{1}{2}$-inch pipe extending around it next to the wall. In the first experiment the side-benches were 34 inches wide with a space of about 2 inches between the benches and the wall, while 2 benches, each 38 inches wide, occupied the center of the house. All benches were 5 inches deep, inside measurements. The shade of the south purlin plate interfered with a uniform exposure of the south side-bench to the light, and the heated air rising between the sides of the house and the side-benches made the soil dryer towards the wall than it was in those parts of the bench nearer the walk. For these reasons the house was fitted for Crop IV with center benches only. There were 2 of these each 6 feet 7 inches wide, separated from

each other and from the sides of the house by walks. With this arrangement there were no pipes beneath or above any of the benches and the circulation of air and the exposure of all portions of the benches to the light were more nearly uniform than they were with the former arrangement. Plate XLIII shows the interior arrangement for Crops II and III, and Plate XLIV shows the north bench as arranged for Crop IV.

The benches were divided into plats large enough to hold from 20 to 32 plants each, the plants being set 8 inches by 8 inches or eight inches by 9 inches apart. In each test three plats were commonly assigned to each soil mixture. These were separated as widely as possible so that the different soils might be alike subject to any inequalities arising from varying conditions of light, heat and moisture in the different portions of the house.

GENERAL TREATMENT.

All plats under experiment were treated alike in all respects. The day temperature during the winter was commonly kept at from 55° to 60° F. and the night temperature from 45° to 50° F.

None but head lettuce was used. Salamander was selected for Crop I, the seed being purchased from a seed firm; for all subsequent tests Rawson's New Hothouse was used, the seeds being purchased from the introducer of that variety. An account will be given hereafter of the various precautions which were taken to securing seedlings uniform in size and vigor. For some crops the seedlings were transplanted, but for others the seed was planted where the plant was to stand till it reached marketable condition. In every instance the seed was planted in the same soil and usually in the same plat in which the plant was to be matured. Repeated measurements of the plants were taken at different periods of growth so that the rate of growth on the different soils might be compared. When the plants reached prime marketable condition each one was weighed and with the later crop each plant was also rated according to its form, solidity, texture and general

appearance and notes were made on the prevalence of tip burn and injury from diseases.

CROP I. WINTER 1895–6.

During the winter of 1895–1896 a soil mixture which had given good results in forcing lettuce at this Station, and which in this report will be called Soil 1, was compared with other soil mixtures which differed from it only in the increased amounts of sand which were added to them. Soil 1 was made of 1 part sand, by bulk, 1 part stable manure and 3 parts rotted sod from a clay loam found on the Station farm. The percentage, by weight, of the ingredients of the different soil mixtures is shown in Table I.

TABLE I.—INGREDIENTS AND CHEMICAL CONSTITUENTS OF SOIL USED FOR LETTUCE FORCING.

(CROP I.)

Soil.	Ingredients.			Chemical constituents. (Water-free samples.)		
	Loam.	Sand.	Manu e.	Nitrogen.	Total phosphoric acid.	Potash.
	Per ct.	Per ct.	Per ct.	P r ct.	Per ct.	Per ct.
1. (bulk)	60.	20.	20.	.....	.....	.....
1. (weight)	63.0	26.3	10.7	0.181	0.161	0.222
2. (weight)	49.1	42.4	8.5	0.161	0.109	0.111
3. (weight)	41.3	51.7	7.0	0.121	0.085	0.090

The loam was prepared by piling sod in alternate layers with stable manure and allowing it to become pretty well rotted so that it was rich, friable and filled with " fibre." The sand was clean and sharp. The manure was fairly well rotted horse manure.

Sample of these soils were given to Mr. W. H. Andrews, assistant chemist, for analysis. His report of the percentages of nitrogen, phosphoric acid and potash, as determined by official methods of analysis, is given in Table I.

In these important elements of plant-food the analyses show that Soil 1 was richest and Soil 3 poorest. This was to be expected because, as Table I shows, the percentage of manure was greatest

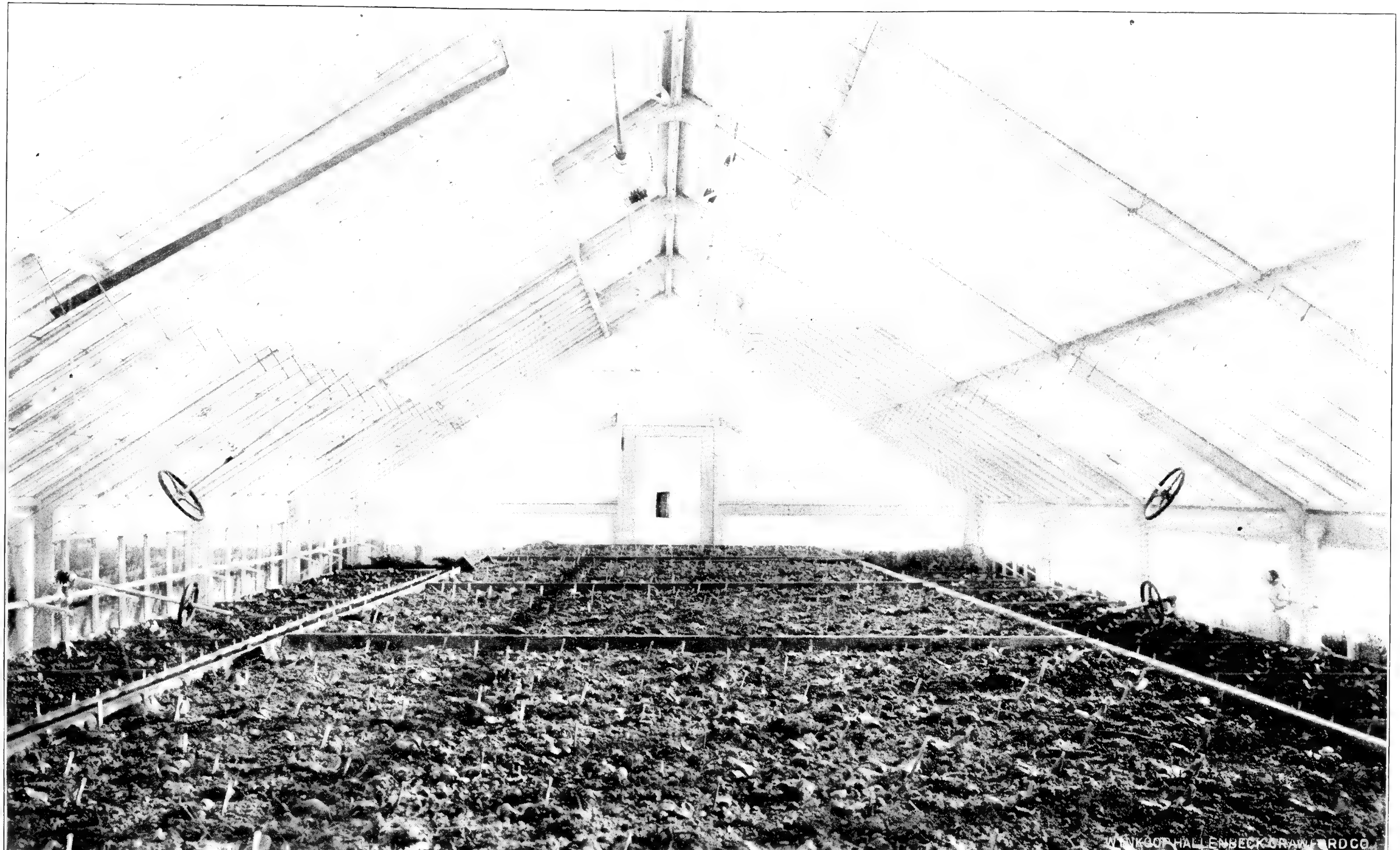

PLATE XLIII.—ARRANGEMENT OF FORCING HOUSE FOR CROPS II AND III.

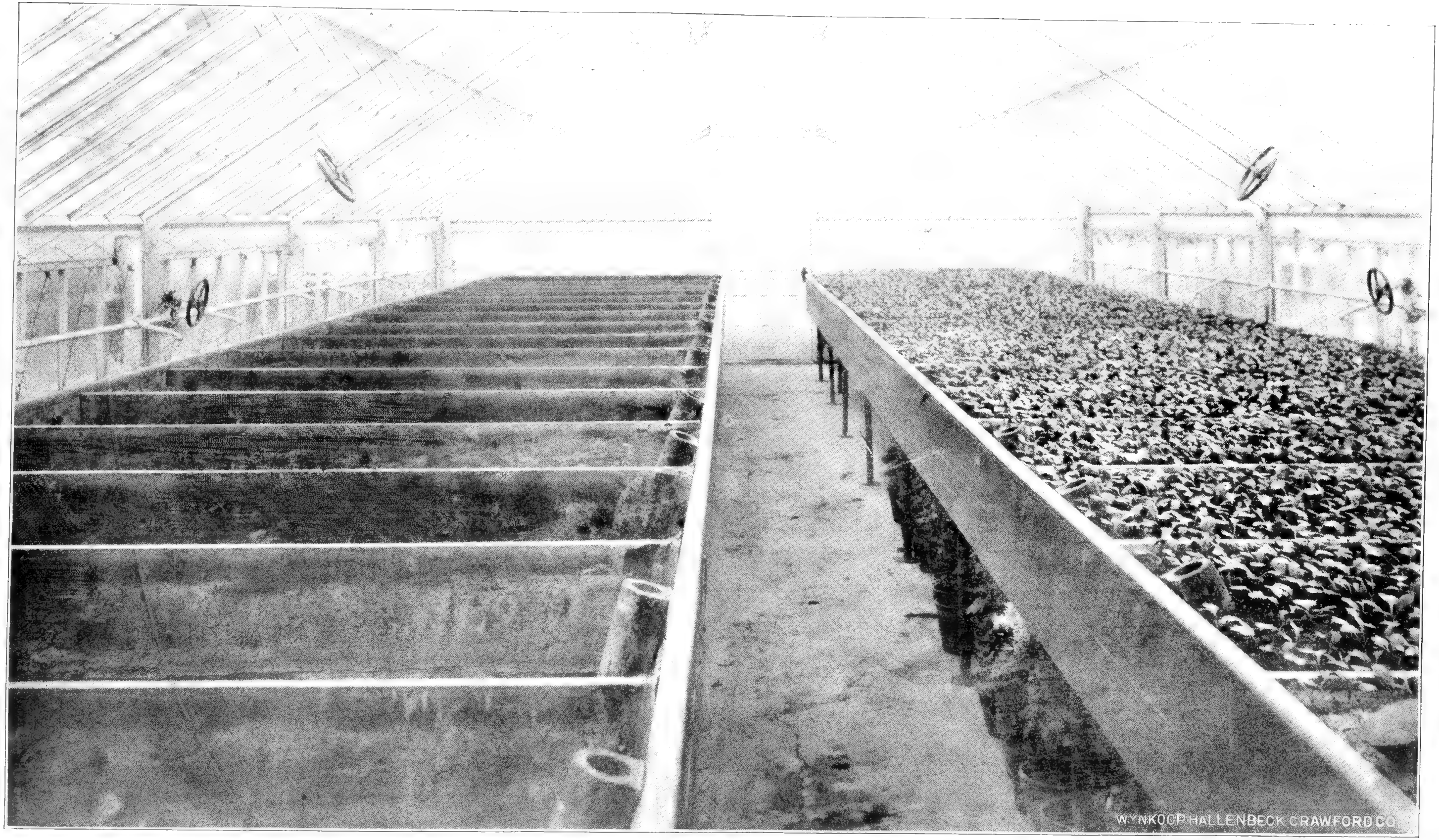

PLATE XLIV.—INTERIOR OF LETTUCE HOUSE AS ARRANGED FOR CROP IV.

in Soil 1, and it decreased in the other soils in proportion as the amount of sand was increased, but, as will be shown later, it is safe to assume that the soils were on equal footing so far as a sufficient supply of nitrogen, phosphoric acid and potash is concerned, because even Soil 3 had a supply far exceeding the requirements of the crop.

The plats in which these soil mixtures were tested were arranged on the south middle-bench and south side-bench of the lettuce house as shown in the diagram. Each plat in the side-bench contained 20 plants. The plats in the middle-bench each contained 32 plants. There were no pipes under the middle-bench, but the side-

South Middle-Bench.

	Soil 1.		Soil 3.		Soil 2.	
Plat	13	14	15	16	17	18

Walk.

			Soil 3.	Soil 2.	Soil 1				Soil 3.	Soil 2.	Soil 1.
Plat 12	11	10	9	8	7	6	5	4	3	2	1

South Side-Bench.

bench had two coils of $3\frac{1}{2}$-inch hot-water pipes underneath. A thin layer of sphagnum was spread over the perforated tile bottom to help retain the moisture and the benches were filled with $5\frac{1}{2}$ inches of soil. In order to prevent any modifications of the results of the test which might arise from checking the growth unequally in transplanting, the seeds were planted where the plants were to stand till they reached marketable condition. Selected seeds of Salamander lettuce from Peter Henderson & Co., New York, each weighing 1.5 milligrams were planted $\frac{3}{8}$ of an inch deep and 8 inches apart in the row, in rows 8 inches apart, each seed being planted opposite the middle of the space between the seeds in the adjacent rows. This gave a distance of almost 9

inches to the nearest seeds in the adjoining rows. The soil was then watered to compact it around the seeds.

A few of the plants damped off or were excluded from the experiment from some other disqualifying cause. All others formed marketable heads with the exception of one plant on Soil 3 which did not form a good head. The averages of the records which are given in Table IV, page 476, show that there was no marked difference in the lettuce on the different soils, but it was very slightly earlier on Soil 2. It has already been stated that the nitrogen, phosphoric acid and potash which these soils contained in every case far exceeded the amount taken up by an ordinary crop of lettuce. Even in Soil 3 which stood lowest in the analyses there were found about 26 times as much nitrogen, 7 times as much potash and 61 times as much phosphoric acid as are found in head lettuce, and an important part of these constitutents was supplied in the humus of the rotted sod and in the stable manure. It is safe to assume that Soils 1, 2 and 3 were practically on the same footing so far as the character and needed amount of these food materials are concerned, and are, therefore, comparable as to the influence on the crop of loosening the texture of the soil by adding sand. In this test the loosening of the texture of the soil by increasing the proportion of sand from 26 per cent in Soil 1 to 52 per cent in Soil 3 had no marked influence on the growth of the lettuce.

CROP II. FALL AND WINTER 1896–7.

Crop II was started in the fall of 1896 for the purpose of observing the effect on lettuce of including in the soil still greater proportions of sand than were used with Soils 1, 2 and 3. The lettuce in Crop I matured very slightly earlier on Soil 2 than it did on either Soil 1 or Soil 3, so a mixture having approximately the same proportions of loam, manure and sand as Soil 2 was prepared for Crop II and called Soil 4. Soil 5 was given twice as much sand as Soil 4, and Soil 6 was made entirely of sand and

manure. The percentage of manure in this test was kept the same for all the soils as the following table shows:

TABLE II.— INGREDIENTS OF SOILS USED FOR LETTUCE FORCING.

(CROP II.)

Soil.	Ingredients.		
	Loam.	Sand.	Manure.
	Per ct.	Per ct.	Per ct.
4. (bulk)	50	25	25
4. (weight)	52.2	32.3	15.5
5. (weight)	19.9	64.6	15.5
6. (weight)	....	84.5	15.5

The ingredients which were used for these soils differed slightly from those which were used for Crop I. The manure was horse manure with the long straw and the dry rough portions removed. It had been turned several time and was partly rotted. The sand was much like that used for Crop I, but the loam was composed of rotted sod from a medium clay loam[1] which had somewhat more sand and gravel than that which was used for the preceding crop and it also differed from it in that it was not piled in alternate layers with manure.

In order to insure for Soil 6 a superabundance of available nitrogen, phosphoric acid and potash, it was given a liberal application of commercial fertilizers in addition to the manure. This made it necessary to extend the same treatment to Soils 4 and 5. High-grade sulphate of potash, 50 per cent actual potash, was applied to each at the rate of 400 pounds per acre; and acid phosphate containing about 15 per cent available phosphoric acid, at the rate of 600 pounds per acre. Nitrate of soda containing 15.7 per cent nitrogen, was applied to the growing crop at the rate of 133 1/3 pounds per acre in two applications.

The 3 soils were arranged in 9 plats on the north and south side benches of the lettuce-house as shown in the accompanying

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1 The mechanical analysis of this soil is given on page 479, and the chemical analysis on page 487.

diagram. Plate I shows the interior of the lettuce-house as arranged for Crops II and III.

NORTH BENCH.

				Soil 5.		Soil 4.	Soil 6.			Soil 5.
Plat	1	2	3	4	5	6	7	8	9	10
		Soil 4.	Soil 5	Soil 6.				Soil 4.	Soil 6.	
Plat	20	19	18	17	16	15	14	13	12	11

SOUTH BENCH.

For Crop I each seed was weighed and only seeds of a uniform weight, 1.5 milligrams, were planted. This plan was afterward abandoned because it did not insure as uniform seedlings as were desired for the test.[2] For Crop II the seeds were sown in each plat in furrows exactly one-half inch deep, no attempt being made to select seeds of uniform weight. They were then covered with

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[2] The time required with Crop I for the germination of the seeds is shown for each plat in the following table, together with the measurements of the plants fifty-four days after seed-planting and the percentage of seeds which germinated. It should be compared with Table B, page 470.

TABLE A. GERMINATION AND GROWTH OF LETTUCE SEEDS.
(CROP I.)

Soil.	Plat.	Time required for germination.		Spread of plants 54 days after seed planting.		Per cent. of seed germinated.
		Average.	Variation.	Average.	Variation.	
		Days.	Days.	Ins.	Ins.	
1. Loam 3 parts	1	11.67	8 to 18	5.15	3 to 8	90
Sand 1 part	7	8.05	7 to 13	7.74	6 to 9.75	100
Manure 1 part	13	9.97	6 to 20	7.45	4.5 to 9	97
2. Same weight of loam and	2	9.53	7 to 14	7.25	5 to 9.50	95
manure as Soil 1 with	8	9.11	7 to 14	7.38	2.75 to 9	95
twice as much sand	17	9.13	7 to 40	7.69	2 to 9.50	94
3. Same weight of loam and	3	10.17	6 to 33	7.53	2 to 9.75	95
manure as Soil 1 with	9	8 63	6 to 14	7.37	3.75 to 9.75	85
three times as much sand.	15	7.67	6 to 11	7.65	5 to 9	87

A study of the later records of those plants which germinated most slowly shows that, as a rule, they did not equal plants from earlier germinations either in size or in earliness of reaching marketable maturity.

fine soil and watered so as to compact the soil around the seed. When the seedlings began to appear those germinating each day were marked with small wooden pegs indicating the day on which the germination occurred. The seed was sown October 27, 1896. It germinated quite evenly on November 1 and 2, and only plants which germinated on these dates were allowed to grow. They were thinned November 2 and again November 4, so that vigorous plants, uniform in size, with fully expanded cotyledons stood about one inch apart in the row. From these seedlings the final selection of plants for the test was made November 20.

The plan was to set each plat with seedlings which had germinated in that plat and at the same time use plants of uniform size for transplanting in all plats. It was found that this could not be done because in Plats 10 of Soil 5, 12 of Soil 6 and 13 of Soil 4, which were located in the end of the house farthest from the boiler, the growth was slower so that smaller plants had to be used in setting those plats than were used in the rest of the house. Notwithstanding this the original plan of setting each plat with seedlings from that plat was followed. The height of each seedling when it was transplanted was $1\frac{1}{2}$ inches for all plats except 10, 12 and 13. For Plat 10 plants $1\frac{3}{8}$ inches and for Plats 12 and 13 $1\frac{1}{4}$ inches in height were used.

Some plants did not form marketable heads. These were cut and weighed when the last of the marketable heads were cut. The results as set forth in Table 4, page 476, show that there was but a difference of one day at the most in the average time required for maturing the plants on the different soils. The percentage of marketable heads was the same for all soils, being 96 per cent. The average weight of the mature plants was about alike on Soils 4 and 5, but noticeably greater on Soil 6. The heads which grew on Soil 6 were looser and the lettuce was more delicate in texture and would not be expected to stand handling as well as that which was grown on Soils 4 and 5. Soil 6, as has been stated, contained no loam but was made of sand and manure, while Soils 4 and 5 contained different proportions of clay loam.

CROP III. WINTER AND SPRING OF 1897.

As soon as Crop II was removed, the soil in each plat was turned several times and given another application of acid phosphate and sulphate of potash at the same rate as before, making the total application amount to 1,200 pounds of acid phosphate and 800 pounds of sulphate of potash per acre, including what had been applied for the previous crop. Soil 4 was thus changed to 4a, 5 was changed to 5a and 6 was changed to 6a.

Again the effort was made to avoid any differences in the growth of the plants which might come from unequal check to the growth in transplanting by planting several seeds in each place where a plant was to stand permanently, and afterwards removing all but one plant. February 18 about 10 seeds were planted in a place, covered with one-half inch of soil and lightly watered. Only plump, healthy looking seeds were planted. They were taken from the same packet which furnished the seeds for Crop II. March 15 the plants were thinned leaving one plant in each place.[3]

[3] The size of the first leaf on March 15 was used as a guide in selecting the seedlings which were to remain so as to have them as nearly uniform in size as possible. The average measurements and the variation in size are shown for each plat in Table B. A comparison of this table with Table A, page 468, shows that greater uniformity in the seedlings was secured in this way than by the method of planting seeds of uniform weight which was followed for Crop I.

TABLE B. AVERAGE SIZE OF LETTUCE SEEDLINGS TWENTY-FIVE DAYS AFTER SEED PLANTING.

(CROP III.)

Soil.	Plat No.	Average length of first leaves	Variation in size of first leaves.
		Ins.	Ins.
4a. Amount of sand about like Soil 2	6	1.30	1.125 to 1.5
	13	1.23	1 to 1.375
	19	1.28	1 to 1.5
5a. About twice as much sand as Soil 4	4	1.33	1.25 to 1.5
	10	1 25	1 to 1.5
	18	1.20	0.75 to 1.375
6a. Sand and manure; no loam	7	1.33	1 to 1.5
	12	1.10	0.75 to 1.375
	17	1.20	1 to 1.5
4a.	Three p'ats.	1.27	1 to 1.5
5a.	Three plats.	1.26	0.75 to 1.5
6a.	Three plats.	1.19	0.75 to 1.5

Forty-three days after seed planting, when the plants were well established and making good growth, the first application of nitrate of soda was made at the rate of 33 1-3 pounds per acre. It was applied in solution to the soil around each plant. Two other applications were made at intervals of 10 days. When the time came for the fourth application it was not given because the plants were nearly mature. The results as set forth in Table 4, page 166, confirm the results which were obtained on the same soils with the preceding crop. The length of time required to mature the crop was shorter because Crop II matured in midwinter while Crop III matured in May and had the advantage of the increasing light and heat as the season advanced.

Considering the results with both crops it is seen that the average weight was lightly greater with Soils 5 and 5a than with 4 and 4a. On Soils 6 and 6a the lettuce was noticeably larger and heavier although the texture was not so good and the heads not so firm as they were on Soils 4, 4a, 5 and 5a. On Soils 4 and 4a which contained the most loam and which, it will be remembered, were much like Soil 2, the lettuce was best in firmness of head, texture and general appearance.

CROP IV. FALL AND WINTER 1897–8.

The arrangement of the benches was changed for Crop IV by taking out the side-benches and having walks next the wall on all sides of the house for the reasons set forth on page 462. The rest of the floor space was occupied by two wide benches, separated by a walk passing lengthwise through the middle of the house. The heating pipes were placed next to the outside walls. By this arrangement the conditions of light, heat and the circulation of air were made more uniform throughout the area occupied by the benches. The depth of the benches was 11 inches inside. The plats were separated from each other by board partitions cemented at the joints and over the bottom to provide for sub-watering and to prevent the passage of soil water from one plat to another, as illus-

trated in Plate XLIV. The soils were arranged, as shown by the diagram, in plats each having an area 15 1-4 sq. ft. inside measurement. A line of tile extended along the middle of the bottom of each plat with an upright tile at one end leading to the surface through which the plats were watered.

The soils were arranged in plats on the two benches as shown in the accompanying diagram. The figures designate the numbers of the soil mixtures.

Diagram Showing Location of Soils.*

(Crop IV.)

																Walk.
11	10	9	16	15	17	7	8	11	7	8	7	8	16	15	17	North bench.
																Walk.
16	15	17	11	10	9	8	8	8	11	7	7	7	11	10	9	South bench.
																Walk.

* Soils 7 to 11 inclusive were included in this test. Soils 15, 16 and 17 were included in the fertilizer test, which will be considered later.

A medium clay soil furnished the loam for all soil mixtures of Crops I, II and III except 6 and 6a which contained no loam. With Crop IV the clay loam was compared with a very light sandy loam as a basis for soil mixtures for forcing lettuce.

Nitrogen, phosphoric acid and potash were applied equally to all the soils and in quantities sufficient to insure a superabundant supply of these elements of plant food. This was done so that the influence of the other factors in the adaptability of soil mixtures to forcing lettuce might be brought out more clearly. Each plat was given an application of high grade sulphate of potash, about 50 per cent actual potash, at the rate of 400 lbs. per acre, and acid phosphate, about 15 per cent available phosphoric acid, at the rate of 600 lbs. per acre. About 5 weeks after the seed was planted nitrate of soda was applied to each plat at the rate of 33 1-3 lbs. per acre. This was repeated weekly till 11 applications were given, making a total amount of 366 lbs. per acre. The nitrate of soda was applied in solution around each plant in uniform amounts till the plants became so large that they crowded each other, after which the total amount for each plat was applied through the tiles in subwatering.

In the soil mixture which was tested with Crop IV wherever stable manure was used it constituted one-third of the soil. In one case a mixture was made which contained one-third manure, one-half sand and one-sixth clay loam. In addition to this the clay loam and the sandy loam were tried with and without stable manure. All these soils were given commercial fertilizers in equal amounts.

The clay loam was composed of pretty well rotted sod of the same character as that used for Crops II and III. The sand was sharp and unscreened, from the shore of Seneca Lake. The sandy loam was from the side of a field formerly occupied by a vineyard but now planted to raspberries. It was composed chiefly of soil which had been blown from the field and lodged on the sod at the side of the field. The manure was from the city stables. It was thoroughly mixed and pretty well rotted.

The following statement shows the percentage of the ingredients of each of the soils which were tested with Crop IV.

Table III.— Ingredients of Soils Used for Lettuce Forcing.
(Crop IV.)

Soil.	Ingredients.			
	Clay loam.*	Sandy loam.*	Sand.	Manure.
	Per ct.	Per ct.	Per ct.	Per ct.
7	100	....	....	....
8	....	100	....	....
9	....	66 2-3	....	33 1-3
10	66 2-3	....	....	33 1-3
11	16 2-3	....	50	33 1-3

Before planting the seed it was dropped into water and the light seeds were skimmed off. The seed was then sown on each plat in furrows $\frac{3}{8}$ of an inch deep following the plan which was used with Crop II as stated on page 468. The seed was sown November 23, 1897, and the first germinations occurred November 29. On Soils 9 and 11 the germination was less rapid and not so uniform as on the other soils. The seedlings which appeared on the first day of germination were comparatively few and hence were discarded; those which appeared on the second and third days were allowed to grow. In the case of Soils 9 and 11 it was found necessary to keep those which appeared on the fourth day also in order to have enough seedlings from which to select plants for the experiment. All other seedlings were promptly cut out. The seedlings were thinned December 9. As soon as they had developed sufficiently to show which were most vigorous they were transplanted to permanent places in the same plat in which they were growing and set $8\frac{1}{2}$ by 9 inches apart. This was done December 24. All seedlings were measured and those which were selected for transplanting were nearly uniform in size, varying no more than 1-4-inch in the plat and in the average not more than 1-3-inch between different plats. A few of the plants, about 1 per cent, afterwards damped off or were discarded for some other disqualifying reason; all others reached marketable size

* The mechanical analyses of the clay loam and of the sandy loam are given on page 479. The chemical analyses may be found on page 487.

although some could not be marketed on account of injury from tip-burn and rot. A portion of the crop was shipped to a commission man at Rochester, N. Y., who pronounced it equal to the best grades from Boston houses.

There was a marked difference in the firmness, size and appearance of the lettuce on different soils as may be seen by referring to the averages of the records for Crop IV which are given in the following table. There was considerable difference too, in the lettuce on different soils as to its susceptibility to rot and tip-burn.

In order that the results with Crops I, II, III and IV may be more readily compared the averages of their records are presented together in Table 4.

TABLE IV.— AVERAGE TIME OF GROWTH, WEIGHT PER HEAD, ETC., OF FORCED LETTUCE.

(CROPS I, II, III AND IV.)

No. of soil.	Soil ingredients. Sandy loam.	Clay loam.	Sand.	Manure.	Crop.	Date of seed planting.	Average days from seed planting till maturity.	Average weight per head.	Heads marketable.	Texture, appearance and firmness.— Scale of 100.	Tip-burn.— Scale of 100.*
	Per ct.	Per ct.	Per ct.	Per ct.				Ozs.	Per ct.		
						1895.					
1.......	0	63	26.3	10.7†	I	Oct. 26	102.9	6.25	100	No record kept.	
2.......	0	49.1	42.4	8.5†	I	26	101.7	6.27	100		
3.......	0	41.3	51.7	7 †	I	26	102.3‡	6.28	98.3		
						1896.					
4.......	0	52 2	32.3	15.5§	II	Oct. 27	97.3‡	5.36	96		No record kept.
5.......	0	19.9	64.6	15.5§	II	27	96.2‡	5.49	96		
6.......	0	0	84 5	15.5§	II	27	97 ‡	7.07	96		
						1897.					
4a......	0	52.2	32.3	15.5§	III	Feb. 18	76 4	6.51	100	56	
5a......	0	19.9	64 6	15.5§	III	18	77.6	6.84	100	50	
6a......	0	0	84.5	15 5§	III	18	76.7	7.70	100	52	
7.......	0	100	0	0 §	IV	Nov. 23	95.9	7.50	100	76	0
8.......	100	0	0	0 §	IV	23	92.9‡	7.94	97.2	95	0.1
9.	66⅔	0	0	33⅓ §	IV	23	89.4‡	7.49	97.1	59	8.07
10.	0	66⅔	0	33⅓ §	IV	23	83.2‡	8.63	98.5	97	6.2
11.......	0	16⅔	50	33⅓ §	IV	23	86.3	8.23	100	85	21

* In estimating the injury from tip-burn, 100 indicates greatest injury.

† No commercial fertilizers were added to these soils.

§ These soils were given N P^2 O^5 and K^2 O in commercial fertilizers in liberal quantities.

‡ Not including plants which failed to reach marketable condition.

The sandy loam, Soil 8, gave earlier, slightly heavier and much better lettuce than the clay loam, Soil 7; but when manure was added to each at the rate of 33 1-3 per cent quite different results followed, the clay loam and manure, Soil 10, yielding much earlier, healthier and heavier lettuce than the sandy loam and manure, Soil 9. In fact Soil 10 proved to be the best mixture which was tried with Crop IV, the lettuce which was grown on it being from 3 to 13 days earlier, as well as heavier and better than that which was grown on the other soils.

On comparing the records of the two soils which contained the sandy loam, namely Soils 8 and 9, it is seen that in firmness, texture and general appearance the crop on Soil 8 which had no stable manure, ranked far above that on Soil 9, one-third of which was composed of stable manure. Moreover, it was practically free from tip-burn while the lettuce on Soil 9 suffered seriously from this trouble. The mixing of partly rotted manure with the very light sandy loam gave a soil so loose in texture that capillary action was too much interfered with to get the best results in plant growth. This is the only apparent explanation of the fact that Soil 9 did not grow as good lettuce as Soil 8 although it was much richer in plant food.

That the clay loam should give better results in forcing head lettuce than the sandy loam is especially significant, because in many instances commercial growers seem to prefer a sandy soil for forcing lettuce. Mr. F. L. Marsh, of the *Michigan Fruit Grower*, has very kindly furnished for publication here a statement of the way in which the forcing of lettuce[4] has become localized in a certain section of Grand Rapids, Michigan, because of the character of the soil which is found there. He says, "Lettuce growers at Grand Rapids are agreed that sand, light but fine, is the most suitable soil for culture of that plant. Its porosity seems

[4] It should be remarked that the kind of lettuce grown at Grand Rapids is not a head lettuce but an earlier maturing loose lettuce known by the name "Grand Rapids," while in the experiments at this Station only varieties of head lettuce were tried.

to be adapted to lettuce; yet the extreme coarseness of loose sand is not desired. Radishes thrive in this soil, and cucumbers also do well, but for the latter a little heavier soil is preferred. Those who grow carnations have found a clay loam most suitable, while rose culturists select the heaviest clay. On account of this peculiarity of soil adaptation there may be seen on one side of this city, the soil being sandy, a village of greenhouses devoted to vegetable growing, while upon another border, whose soil is clay, flower culture is equally the specialty."

It is well known that head lettuce from Boston forcing houses maintains a reputation for a high degree of excellence. Galloway[5] gives the mechanical analysis of a type of lettuce soil from Boston, showing that it contains a relatively large amount of organic matter and of medium, fine and very fine sand, while there is a relatively small amount of fine silt and clay. In the place cited Galloway says:

By certain processes, which it is not necessary to describe here, any soil may be separated mechanically into parts, which have received certain conventional names. In the mechanical analyses of soils, eight of these parts are recognized as follows:

1. Fine gravel.
2. Coarse sand.
3. Medium sand.
4. Fine sand.
5. Very fine sand.
6. Silt.
7. Fine silt.
8. Clay.

Taking any ordinary soil, for example, it may be divided into the foregoing constituents, the identity of each being determined by the size of the grains composing it. Thus fine gravel has a diameter of 1 to 2 millimeters,* coarse sand, ½ to 1 millimeter, and so on, clay being the smallest, the size of the grains in this case being only 1-10000 to 5-1000 of a millimeter in diameter. The analysis, in brief, is simply the mechanical separation of a soil into eight conventional parts, the parts themselves being fixed by the size of the grains composing them. If we make such an analysis of a soil best adapted to the growth of lettuce, the Boston soil, for example, we find the amounts of the various constituents as follows:

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[5] *American Gardening*, 16: 135, Apr. 13, 1895.

* A millimeter is approximately 1-25 of an inch.

MECHANICAL ANALYSIS OF TYPE SOIL ADAPTED TO THE GROWTH OF LETTUCE. (AIR-DRIED.)

Size of grains in millimeters.	Name of parts.	Per cent of each part.
2–1	Fine gravel	3.89
1–.5	Coarse sand	5.39
.5–.25	Medium sand	10.50
.25–.1	Fine sand	17.18
.1–.05	Very fine sand	32.08
.05–.01	Silt	15.13
.01–.005	Fine silt	1.19
.005–.0001	Clay	3.10
Total mineral matter		88.46
Moisture		2.78
Organic matter		12.72
		103.96

The mechanical analysis of the Geneva clay loam and the sandy loam which were used in the soil mixtures for Crop IV, made by Mr. E. B. Hart, assistant chemist, from samples which were taken before any manure or commercial fertilizers had been added to them, gave the following results. The difference between the weight of the original sample and the sum of the weights of the gravel, sand, silt, clay and organic matter is here classed as unsettled clay and added to the weight of the clay.

TABLE V.— MECHANICAL ANALYSES OF SOILS USED FOR LETTUCE FORCING. (CROP IV.)

	Geneva clay loam.	Sandy loam.
	Per ct.	Per ct.
Fine gravel	3.32	0.51
Coarse sand	5.20	0.69
Medium sand	20.71	9.49
Fine sand	43.45	77.50
Very fine sand	.94	2.44
Silt	7.96	1.60
Fine silt	1.64	1.23
Clay	*9.86	†3.79
Organic matter	7.02	2.75

* Including 1.39 unsettled clay. † Including 1.03 unsettled clay.

These analyses show that the percentage of organic matter is considerably higher in the Boston soil than in the Geneva clay loam and more than four times as great as in the sandy loam, but in this respect the soils are not comparable, for Mr. Galloway informs me that the analysis of the Boston soil was made after a liberal amount of manure had been added to it, while the Geneva clay loam and the sandy loam were analyzed before any manure had been added to them. These analyses may be compared more readily by means of graphic representations. See Plate XLV.

There is about the same amount of fine gravel and coarse sand in the Boston soil as in the Geneva clay loam, but the latter has twice as much medium sand and two and one-half times as much fine silt as the Boston soil. It has practically none of the very fine sand while the Boston soil has 32 per cent. Of silt, very fine silt and clay combined, the two soils have about the same amounts, but the Boston soil has twice as much silt as the Geneva clay loam and the latter has almost three times the amount of clay that is found in the Boston soil.

The sandy loam shows a very small percentage of clay and of organic matter while it contains over 90 per cent of sand and gravel.

The clay loam was used as an ingredient of three mixtures in Crop IV, namely, Soils 7, 10 and 11. On Soil 7, which was composed wholly of the clay loam, the crop was not nearly as good as it was on either Soil 10 or Soil 11, each of which contained one-third manure. The use of the manure improved the mechanical condition of the clay loam and gave results quite the opposite of those which followed its use on the sandy loam. The best crop was grown on Soil 10, composed of two-thirds clay loam and one-third manure. In making Soil 11, which contained one-sixth clay loam, one-third manure and one-half sand, this soil mixture was changed by substituting sand for much of the clay loam; but the change was not beneficial, for the lettuce crop was not so good on Soil 11 as it was on Soil 10. It should be remembered that on all soil mixtures of Crop IV which have been considered

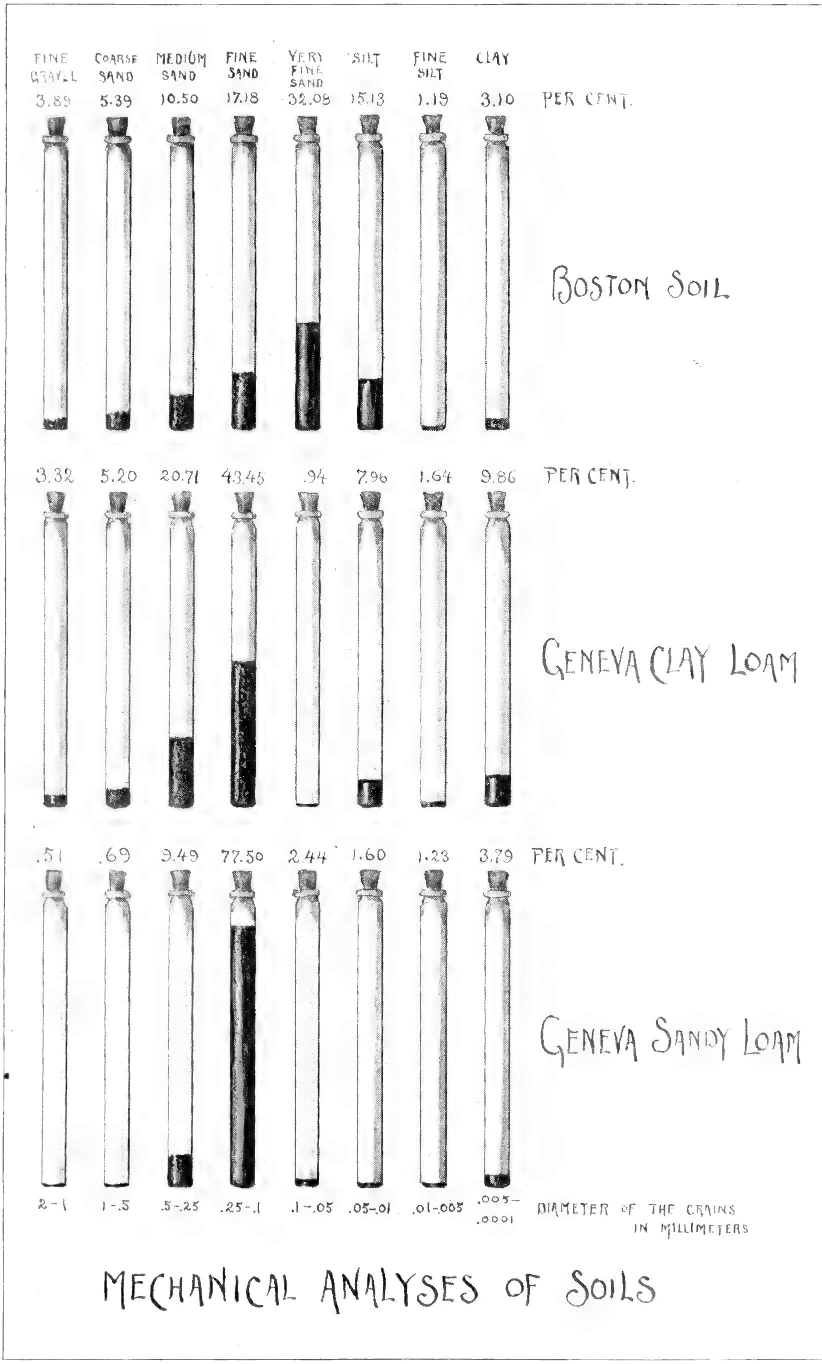
FINE GRAVEL
COARSE SAND
MEDIUM SAND
FINE SAND
VERY FINE SAND
SILT
FINE SILT
CLAY
3.89 5.39 10.50 17.18 32.08 15.13 1.19 3.10 PER CENT.
BOSTON SOIL
3.32 5.20 20.71 43.45 .94 7.96 1.64 9.86 PER CENT.
GENEVA CLAY LOAM
.51 .69 9.49 77.50 2.44 1.60 1.23 3.79 PER CENT.
GENEVA SANDY LOAM
2-1 1-.5 .5-.25 .25-.1 .1-.05 .05-.01 .01-.005 .005-.0001
DIAMETER OF THE GRAINS IN MILLIMETERS
MECHANICAL ANALYSES OF SOILS

PLATE XLV.

above, acid phosphate, sulphate of potash and nitrate of soda were applied equally and in liberal quantities.

Taking the whole series of experiments into consideration it appears that the soils have been varied from pure sand and manure on the one hand to medium clay loam and manure on the other. A very light sandy loam also has been tried and the texture of the clay loam has been lightened by adding sand in various proportions. There is nothing in the results to show that a light sandy soil is essential to securing the best results in forcing head lettuce. In fact, in these tests the best lettuce has been grown on the clay loam where its texture has been loosened by mixing liberal quantities of stable manure with the rotted sod. This produces a soil full of "fibre" with a great capability for conserving moisture and with a superabundance of available plant food.

With 50 per cent of sand added to the clay loam and manure, see Soil 11, Crop IV, the crop was three days later, the heads averaged slightly less in weight, the texture, firmness and general appearance were not so good and the tip-burn decidedly increased. When the texture of the clay loam was loosened by increasing the sand 16 per cent and 26 per cent with Crop I and 32 per cent with Crops II and III, the only noticeable advantage was a very slight tendency to earlier maturity where the larger percentages of sand were used.

A comparison of the records of the four crops, as set forth in Table 4, might at first give the impression that the different crops do not agree very closely as to their results, but a more careful study will show that in reality they conflict with each other but very little, if at all. With the first crop there was no marked difference in the weight of the lettuce on the different soils. With the second crop the sand and manure, Soil 6, gave decidedly heavier plants than did the soils which contained clay loam, but the latter really gave superior lettuce, for the plants on Soil 6 formed rather loose heads, actually less valuable for market than the more compact though somewhat smaller lettuce which was

grown on the clay loam soils. With the third crop the results were quite similar to those which were found with the second crop. With the fourth crop the evidence was stronger than before in favor of the medium heavy clay loam lightened with fairly well rotted stable manure, as the best of the soil mixtures which were tried for forcing lettuce. The lettuce which it produced was not only superior to that which was grown on the sandy soil, in texture of leaf, firmness of head and general appearance, but it was also heavier. In the last-named particular the results differed from those which were obtained with Crops II and III but otherwise they do not conflict with them.

II. EXPERIMENTS WITH COMMERCIAL FERTILIZERS IN FORCING HEAD LETTUCE.*

S. A. Beach.

SUMMARY.

Stable manure with and without commercial fertilizers was tried in clay loam mixtures and in sandy loam mixtures for forcing head lettuce. Nitrate of soda was also used in varying quantities in connection with stable manure, acid phosphate and sulphate of potash.

On clay loam mixed with 15.5 per cent stable manure by weight a slight increase in growth followed the use of nitrate of soda but with double this application of manure practically no advantage followed the use of nitrate of soda, either on the clay loam or on the sandy loam.

No advantage was gained either on the clay loam or the sandy loam from the addition of sulphate of potash and acid phosphate when the soils had already received a heavy application of stable manure.

Excellent lettuce was produced on the sandy loam by using commercial fertilizers with no stable manure.

A heavy application of stable manure to the sandy loam put the soil in poor mechanical condition and a crop of inferior lettuce resulted.

The mechanical condition of the clay loam was improved by a heavy application of stable manure. This mixture produced much better lettuce than was grown on the clay loam where commercial fertilizers were used instead of stable manure.

* **Reprint from Bulletin No. 146.**

INTRODUCTION.

Some experiments with the use of commercial fertilizers in forcing lettuce were started in the fall of 1896 in connection with the tests of soil mixtures which have been discussed on preceding pages. Four soil mixtures were tried at this time, three of which received acid phosphate, sulphate of potash and stable manure liberally, and in equal quantities, and differed from each other only in the amounts of nitrate of soda which were applied to them. The fourth mixture, Soil 12, received the same amount of stable manure as the others but none of commercial fertilizers, as is shown in the following table:

TABLE VI.— INGREDIENTS OF SOILS USED AND FERTILIZERS APPLIED IN LETTUCE FORCING.

Soil mixture.	Ingredients (by weight).			Fertilizers applied per acre.		
	Clay loam.	Sand.	Stable manure.	Acid phosphate.	Sulphate of potash.	Nitrate of soda.
	Per ct.	Per ct.	Per ct.	Lbs.	Lbs.	Lbs.
4	52.2	32.3	15.5	600	400	133 1-3
12	52.2	32.3	15.5	...	...	....
13	52.2	32.3	15.5	600	400	....
14	52.2	32.3	15.5	600	400	266 2-3

A head lettuce, Rawson's New Hothouse, grown from purchased seed, was used for these tests.

After this crop was removed, acid phosphate and sulphate of potash were applied to the soils which had received them before and at the same rate as formerly. All soils were then turned and prepared for another crop. The method of planting the seeds and selecting and managing the plants was the same for all soils as for Soil 4a, Crop III, which have been described on page 470.

Six weeks after seed planting, when the plants had become well established, nitrate of soda was first applied at the rate of 33 1-3 pounds per acre for Soil 4a and 66 2-3 pounds for Soil 14a. Two similar applications followed at intervals of 10 days, making the

total application at the rate of 100 pounds per acre for Soil 4a and 200 pounds per acre for Soil 14a, which was somewhat less than the rate of the application of the preceding crop. The average of the records of the two crops which have thus far been considered are presented in Table 7.

Soil 4 is identical with Soil 4 of the soil mixture tests. See page 466. It was made by one part manure by bulk, one part sand and two parts clay loam, the percentage by weight being 15.5 per cent manure, 32.3 per cent sand and 52.2 per cent loam. When the soils were mixed, all except No. 12 received acid phosphate, containing about 15 per cent available phosphoric acid, at the rate of 600 pounds per acre, and sulphate of potash, containing about 50 per cent actual potash, at the rate of 400 pounds per acre. Nitrate of soda was applied in solution to Soil 4 at the rate of 133 1-3 pounds per acre and double that amount was given to Soil 14. These amounts were given in two applications, the first being made about a month after the plants were transplanted to permanent places and the second about three weeks later.[6] The nitrate of soda contained about 15½ per cent of nitrogen. It was given in solution to each plant at the rate of 0.491 grams on Soil 4 and 0.982 grams on Soil 14.

The selection and management of the plants and the treatment of the plats were alike in all respects and have been described for Soil 4. See page 467.

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[6] It was intended to apply the nitrate of soda in three applications so as to make the total amount at the rate of 200 lbs. per acre for Soil 4, and 400 lbs. per acre for Soil 14, but when the time came for the third application it was decided to omit it because the plants had nearly reached marketable condition.

TABLE VII.— AVERAGE TIME OF GROWTH, WEIGHT PER HEAD, ETC., OF LETTUCE FORCED WITH AND WITHOUT COMMERCIAL FERTILIZERS.

(FALL AND WINTER, 1896–7, TWO CROPS.)

No. of soil.	Fertilizers per acre. Phosphoric acid.	Sulphate potash.	Nitrate soda.	Date of seed planting.	Average days from seed planting till maturity.	Average weight per head in ounces.	Per cent of heads marketable.	Texture, appearance and firmness.— Scale of 100.
	Lbs.	Lbs.	Lbs.	1896.				
4	600	400	133 1-3	Oct. 27.	97.3	5.36	95.6	....
12	...	...	......	Oct. 27.	97.	5.04	96.7	....
13	600	400	......	Oct. 27.	96.8	4.97	95.6	....
14	600	400	266 2-3	Oct. 27.	96.6	5.72	97.8	....
				1897.				
4a ...	*600	†400	100	Feb. 18.	76.4	6.51	100	52.7
12a ...	....	....	......	Feb. 18.	74.8	6.67	100	55.7
13a ...	*600	†400	......	Feb. 18.	76.1	6.88	100	59.2
14a ...	*600	†400	200	Feb. 18.	76.9	5.89	100	52.3

Nitrate of soda with stable manure.— In the first test the growth was somewhat more vigorous on Soil 14 which received the greater amount of the nitrate than on either Soil 4 which received the lesser amount or on Soil 13 which received none. Similar results were obtained in the next test where Soil 14a gave slightly larger and better lettuce than did either Soil 4a which received half as much nitrate of soda or Soil 13a which received none. In neither test did the use of nitrate of soda on the soils already well supplied with the stable manure result in sufficient improvement of the lettuce to encourage its use in this way.

Acid phosphate and sulphate of potash with stable manure.— The use of the acid phosphate at the rate of 600 pounds per acre and sulphate of potash at the rate of 400 pounds per acre made practically no difference with the lettuce in the first test as may be seen by comparing Soils 12 and 13. (See Table 7.) But with the second test, the application of these fertilizers having been repeated on Soil 13 at the same rate as before, the lettuce headed

* The total amount including what was applied to this soil for the preceding crop was 1,200 lbs. per acre.

† The total amount including what was applied to this soil for the preceding crop was 800 lbs. per acre.

slightly later on Soil 13a and the heads were slightly heavier than they were on Soil 12a where no commercial fertilizers were used.

Further trials of the commercial fertilizers, both with and without stable manure, were started in the fall of 1897. A medium clay loam was taken as a basis for part of the soil mixtures and a very light sandy loam was used for the rest. Samples of the clay loam and the sandy loam taken before any fertilizers were added to them were given to the chemist for analysis. He reports the following analyses of the air-dried samples,[7] determined by official methods:

CHEMICAL ANALYSES OF CLAY LOAM AND SANDY LOAM.
(CROP OF 1897-8.)

Soil.	Moisture. (H_2O.)	Nitrogen. (N.)	Phos. acid. (P_2O_5.)	Potash. (K_2O.)	Lime. (CaO.)	Organic matter.
	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
Clay loam	13.3	.237	.067	.318	1.022	7.81
Clay loam, water-free..	0	.263	.077	.368	1.179	9.01
Sandy loam	14.0	.075	.111	.083	.343	2.68
Sandy loam, water-free.	0	.087	.129	.097	.399	3.12

The following statement shows the percentage by weight of the ingredients of the different soils:

TABLE VIII.— INGREDIENTS OF SOILS USED AND FERTILIZERS APPLIED IN LETTUCE FORCING. (FALL, 1897.)

Soil.	Ingredients (by weight.)				Fertilizers applied per acre.		
	Clay loam.	Sandy loam.	Sand.	Manure.	Acid phosphate (15 per cent P_2O_5).	Sulphate of potash (50 per cent K_2O).	Nitrate of soda (15½ per cent N).
	Per ct.	Per ct.	Per ct.	Per ct.	Lbs.	Lbs.	Lbs.
7	100	......	....	......	600	400	366
8	......	100	....	......	600	400	366
9	......	66 2-3	....	33 1-3	600	400	366
10	66 2-3	......	....	33 1-3	600	400	366
11	16 2-3	......	50	33 1-3	600	400	366
15	......	66 2-3	....	33 1-3	....	....	....
16	66 2-3	......	....	33 1-3	....	....	....
17	16 2-3	......	50	33 1-3	....	....	....

[7] For mechanical analyses of these soils see page 479.

The commercial fertilizers were used on the clay loam without manure, Soil 7; with manure, Soil 10; and with manure and sand, Soil 11. The manure was used with the clay loam, but without commercial fertilizers in the case of Soil 16, and with the clay loam and sand but without commercial fertilizers in the case of Soil 17.

The commercial fertilizers were used on the sandy loam without manure, Soil 8, and with manure, Soil 9. The manure was used with the sandy loam but without commercial fertilizers in the case of Soil 15.

The selection and planting of the seeds and the selection and management of the plants were the same for all the soils as for Soils 7 to 11 an account of which may be found on pages 475 and 476. The manner of preparing these soils and the character of their ingredients are given on pages 472-474. The acid phosphate and sulphate of potash were applied when the soils were mixed. The nitrate of soda was first applied in solution around each plant at the rate of 33 1-3 pounds per acre about 5 weeks after the seed was planted. Similar applications were made each week for 11 weeks, making the total nitrate of soda which was used amount to 366 pounds per acre. After the plants had grown sufficiently to cover the ground the nitrate of soda was no longer applied to each plant, but the required amount for each plat was supplied through the tiles which were used for subwatering.

Stable manure or commercial fertilizers.— The records of the soils which received commercial fertilizers, instead of stable manure, may be compared in the following table with the records of the corresponding soils which received stable manure instead of commercial fertilizers.

PLATE XLVI.—SAMPLE HEADS OF LETTUCE FORCED ON DIFFERENT SOILS AND WITH DIFFERENT FERTILIZERS.

Table IX.— Commercial Fertilizers vs. Stable Manure for Lettuce Forcing.

No. of soil.	Per ct. of ingredients. Sandy loam.	Clay loam.	Manure.	Commercial fertilizers.	Date of seed planting.	Average days from planting till maturity.	Average weight per head in ounces.	Per cent of heads marketable.	Texture, appearance and firmness.— Scale of 100.	Tip-burn.— Scale of 100.
					1897.					
8...........	100	0	0	*	Nov. 23	92.9	7.94	97.2	95	0.1
15...........	66⅔	0	33⅓	†	Nov. 23	89.3	7.42	97.1	66	69.8
7...........	0	100	0	*	Nov. 23	95.9	7.50	100.0	76	0.0
16...........	0	66⅔	33⅓	†	Nov. 23	82.5	8.57	98.5	98	7.2

Excellent lettuce was produced on the sandy loam with commercial fertilizers instead of stable manure. See Soil 8. In firmness, texture and general appearance it surpassed the lettuce which was grown on the sandy loam with stable manure instead of the commercial fertilizers. See Soil 15. Plate XLVI shows an average head of lettuce from each of these soils. On Soil 15 the lettuce was badly injured by tip-burn, while on Soil 8 it was practically free from the tip-burn, but it suffered somewhat from rot (*Botrytis*), more so, in fact, than did the lettuce on Soil 15.[8]

With the clay loam the results were quite the opposite of those which were obtained with the sandy loam. On Soil 16, where stable manure was used instead of commercial fertiizers, the lettuce was larger, firmer, much better in appearance and about 13 days earlier than it was on Soil 7, which received commercial

* Acid phosphate 600 lbs. per acre, sulphate of potash 400 lbs. per acre, and nitrate of soda 366 lbs. per acre.

† No commercial fertilizers used.

8 Mr. Wright Rives, who forces lettuce extensively near Washington, D. C., states in a letter to the writer, "I have tried nitrate of soda several times and it has always produced bad results, as it keeps the ground on top and under the lettuce damp, which is fatal, as it produces rot. For lettuce the soil must be such that it will dry quickly on top but keep moist below. I make my soil of 2½ to 3 parts of sod to 1 of manure and to this I add about one-third of bank sand."

fertilizers instead of stable manure. The difference in the mechanical conditions of these soils is the apparent reason for the marked difference in the prevalence of tip-burn, the mechanical condition of the clay loam being much improved by the addition of the manure, while on the contrary, the liberal use of manure with the very sandy soil made a soil mixture which was so loose in texture that it did not produce good lettuce.

Stable manure with commercial fertilizers.—The results which were obtained when commercial fertilizers were used instead of stable manure, having been set forth, the use of commercial fertilizers in addition to stable manure will now be considered. Soils 9, 10, 11, 15, 16 and 17 each contained 33 1-3 per cent of stable manure. In addition to the manure, Soils 9, 10 and 11 received phosphoric acid, 600 pounds per acre, sulphate of potash, 400 pounds per acre, and nitrate of soda, 366 pounds per acre. The average of the records for each of these soils are shown in the following table:

TABLE X.— STABLE MANURE WITH COMMERCIAL FERTILIZERS.

No. of soil.	Per cent of ingredients. Sandy loam.	Clay loam.	Sand.	Manure.	Commercial fertilizers.	Date of seed planting.	Average days from seed planting till maturity.	Average weight per head in ounces.	Texture, appearance and firmness.— Scale of 100.	Tip-burn.— Scale of 100.
						1897.				
9.......	66⅔	0	0	33⅓	*	Nov. 23	89.4	7.49	58.6	70.8
15.......	66⅔	0	0	33⅓	†	Nov. 23	89.3	7.42	66.4	69.8
10.......	0	66⅔	0	33⅓	*	Nov. 23	83.2	8.63	96.6	6.2
16.......	0	66⅔	0	33⅓	†	Nov. 23	82.5	8.57	97.5	7.2
11.......	0	16⅔	50	33⅓	*	Nov. 23	86.3	8.23	84.6	21.0
17.......	0	16⅔	50	33⅓	†	Nov. 23	87.2	8.45	84.2	32.4

Soil 9 received commercial fertilizers while Soil 15 did not; otherwise these two soils were alike. The only difference which

* These soils received acid phosphate, 600 lbs. per acre, sulphate potash, 400 lbs. per acre, and nitrate of soda 366 lbs. per acre.

† No commercial fertilizers were used.

could be detected in the lettuce on these two soils was that the general appearance, firmness and texture were a little better where no commercial fertilizers were used.

Soils 10 and 16 were alike except that 10 received commercial fertilizers while 16 did not. Practically no difference could be detected in the lettuce on these two soils.

Soils 11 and 17 were alike except that 11 received commercial fertilizers while 17 did not. Practically no difference could be found in the earliness, weight or appearance of the lettuce on these two soils but the tip-burn was a little less injurious on the soil which received the commercial fertilizers. Figure 17, Plate XLVI, shows an average specimen of lettuce on Soil 17.

In the two crops of the previous season on soils which contained about one-sixth stable manure by weight (15.5 per cent) a slight increase in growth followed the use of nitrate of soda. See Table 7, page 486. But with the crop which has just been under consideration, where the manure constituted one-third of the weight of the soil, practically no advantage resulted from the addition of the commercial fertilizers either to the light sandy loam or to the heavy clay loam.

III. VARIETY TESTS OF STRAWBERRIES, RASPBERRIES AND BLACKBERRIES.*

WENDELL PADDOCK.

SUMMARY.

STRAWBERRIES.

Anlo was the most productive strawberry that fruited this season. It is a good size, midseason berry, firm and attractive. Stahelin produced the largest amount of early fruit and takes second rank as to productiveness among all varieties fruited. Of the late varieties, Rural Gem, Oswego Queen and Michigan are all recommended for trial.

BLACK RASPBERRIES.

Pioneer was the most productive black raspberry and takes second rank in the amount of early fruit produced. Palmer produced the largest amount of early fruit. Both are worthy of a trial. Mills yielded the largest amount of late fruit. It has been quite satisfactory on our grounds. Black Diamond produced a good crop of fruit, but the berries are not as large or perfect as is desirable. Mohler and Eureka are very similar as grown on our grounds this season.

RED RASPBERRIES.

Loudon was the most productive red raspberry this season. This variety is rapidly coming into general favor. Cline produced the largest per cent of its crop early in the season but the total amount was comparatively small. Pomona gave a large

* Reprint of Bulletin No. 147.

amount of early yield and ranks second in total yield; it very closely resembles Marlboro, but it has always been more productive on our soil. Of the late red raspberries Talbot alone is worthy of mention.

BLACKBERRIES.

Ancient Briton and Agawam have been fairly satisfactory on our grounds, but are not as good as some of the less hardy sorts. Minnewaski, New Rochelle and Dorchester are some of the best varieties but they have not always been hardy here at Geneva. Success and Mersereau are promising new sorts.

INTRODUCTION.

In the following pages a brief account is given of the strawberries, raspberries and blackberries that fruited on the Station grounds during the season of 1898. Descriptive notes are given of the strawberries, since many of the varieties fruited on our grounds for the first time this season. The raspberries and blackberries are but briefly discussed, as nearly all of the varieties have been described in former publications of this Station.

It has been our custom to issue a bulletin on small fruits each season; but since new varieties are being introduced so rapidly the burden of testing all newcomers has become too great to warrant the undertaking each year. It has therefore been thought best to discontinue the yearly small fruit bulletin, but to issue an occasional bulletin at such times as may seem best.

STRAWBERRIES.

The plants of all varieties of strawberries mentioned in this bulletin were planted in the spring of 1897. All runners were kept off of the plants till the first day of July. New plants were then allowed to form and an effort was made to restrict the rows to 18 inches in width and to place the plants about 6 inches apart in the row. The plants were cultivated throughout the season and when the ground was frozen in early winter the beds were

mulched with straw. The straw was removed from over the plants in the early spring. As soon as the ground was in condition to be worked the mulch was taken from between the rows and the beds were given one cultivation. The mulch was then replaced where it was left till the end of the fruiting season.

While all varieties were given an equal chance not all of them produced enough plants to make a row of the desired width. Other varieties had to be greatly restricted. In keeping the record of yield a certain length of row was measured, the same for all varieties, and the dates of picking and the weight of the fruit from the measured portion was recorded.

The soil on which the strawberries were grown is a stiff clay loam, unsuited to the best development of this fruit. Consequently many varieties that are valuable in other localities make a very poor showing on our grounds.

The pistillate, or imperfect flowering, varieties have the letter P following the name. Such varieties must be planted near perfect flowering sorts in order to produce fruit satisfactorily. The perfect or staminate varieties have the letter S following the name.

Unnamed varieties and synonyms are printed in italics.

NOTES ON VARIETIES.

ANLO, P. *From A. D. Leffel, Springfield, Ohio.* Blossoms with Beder Wood. Foliage vigorous and healthy, runners abundant, fruit stems medium length; fruit medium to large in size, irregular, good scarlet color, good quality, moderately firm. Ranks first in productiveness this season.

ANNA KENNEDY, P. *From J. T. Lovett, Little Silver, N. J.* Blossoms with Sharpless. Foliage and plants only moderately vigorous; produces a moderate amount of plants; fruit stems short and erect. Fruit medium size, roundish, light scarlet color, firm, with light flesh, quality fair. Season early. Unproductive this year.

ATLANTIC, S. *From L. J. Farmer, Pulaski, N. Y.* Plants moderately vigorous, foliage healthy, runners moderately abun-

dant, fruit stems medium length; fruit medium to large in size, scarlet color, calyx large, firm, good quality. When well grown this is one of the most attractive strawberries. However, but few growers are successful in raising this variety.

Bouncer, S. *From L. J. Farmer, Pulaski, N. Y.* Plants vigorous and abundant plant makers; fruit stem long and erect. Fruit medium to very large, roundish but very irregular, dark scarlet color but with light flesh; firm, fair to good in quality. Moderately productive this season.

Bubach Seedling, S. *From W. E. Doxie, Wappinger Falls, N. Y.* Fruit of largest size, irregular wedge shape, good scarlet color, firm, good quality. Plants vigorous, runners abundant, fruit stems long and erect. Evidently productive. This variety is worthy of further testing on account of its large, handsome fruit and productiveness.

Captain Jack, S. *From Birdseye & Son, Hopewell, N. Y.* Plants vigorous and abundant plant producers, fruit stems long and erect. Fruit medium size, roundish, good scarlet color, fair quality, firm. A fairly productive, medium-early variety.

Carrie, P. *From L. J. Farmer, Pulaski, N. Y.* Blossoms with Sharpless. Plants vigorous, foliage abundant, fruit stems long. Fruit large, long conic, good scarlet color, firm, fair quality, moderately productive on our soil. A seedling of Haverland, which it somewhat resembles.

Clyde, S. *From L. J. Farmer, Pulaski, N. Y.* Plants medium size, vigorous and good plant makers; fruit stems medium length. Fruit medium to large, round conic, light scarlet color, light flesh, moderately firm, fair to good in quality. Very productive. Although grown in a thin, matted row the plants set more fruit than they could properly mature.

Earliest, S. *From Thompson's Sons, Rio Vista, Va.* Plants vigorous and abundant plant makers, fruit stems medium length, erect. Fruit medium size, roundish, conic, light scarlet color, moderately firm, quality good. Resembles Michel Early closely

and like that variety produces a very early but relatively small crop of fruit.

EVANS, S. *From Slaymaker & Sons, Dover, Del.* Fruit large, roundish, conic, light scarlet color, soft, fair quality. Plants vigorous, runners abundant. Fruit stems short and erect. Moderately productive. This variety and Tennyson closely resemble each other.

GANARGUA, S. *From A. A. Mitchell, Palmyra, N. Y.* Plants fairly vigorous, runners moderately abundant, fruit stems short and erect. Fruit medium to large, roundish, good scarlet color, moderately firm, quality fair. Jessie type. Moderately productive.

GARDNER, S. *From W. F. Allen, Salisbury, Md.* Fruit medium to large, irregular conic, light scarlet color, firm, quality fair, rather acid. Fruit stem short and erect; plants fairly vigorous; runners moderately abundant. Unproductive this season.

HALL FAVORITE, S. *From L. J. Farmer, Pulaski, N. Y.* Plants moderately vigorous and moderate plant makers. Fruit stems medium length, erect. Fruit medium or above in size, roundish, good scarlet color, firm, fair quality. Not productive this season.

HENRY, S. *From W. A. Baker, Wolcott, N. Y.* Fruit large, irregular conic, good scarlet color, moderately firm, good quality. Plants vigorous with abundant runners; fruit stems medium. Moderately productive this season. The name of this variety should be suppressed since another variety was first disseminated under this name and since been widely distributed.

HOLLAND, P. *From L. J. Farmer, Pulaski, N. Y.* Blossoms with Sharpless. Fruit large, roundish, good scarlet color with dark flesh, moderately firm, quality good. Plants moderately vigorous with abundant runners, fruit stems medium in length. A number of the plants failed to grow, and therefore the record of yield of this variety cannot be given.

IDEAL, S. *From M. Crawford, Cuyahoga Falls, Ohio.* Plants vigorous, runners abundant, fruit stems short and erect. Fruit

large, round conic, dark scarlet color, firm, quality fair, very acid. Moderately productive.

Isabella, S. *From J. H. Hale, South Glastonbury, Conn.* Plants vigorous, runners moderately abundant, fruit stems short and erect. Fruit medium to large, irregular, dark scarlet color, firm, quality fair, quite acid. Moderately productive this season.

McKinley, S. *From Ellwanger & Barry, Rochester, N. Y.* Plants moderately vigorous and medium plant producers. Fruit large, conical, good scarlet color, moderately firm, quality good. Ranks seventh in productiveness this season.

Michigan, S. *From J. T. Lovett, Little Silver, N. J.* Plants moderately vigorous with abundant runners, fruit stems medium length, erect. Fruit large, irregular conic, good scarlet color, firm, good quality. Recommended for trial as a productive late variety. It ranks fourth in total yield for this season and third in the amount of late fruit produced.

Minneola, S. *From J. L. Childs, Floral Park, N. Y.* Fruit very large, irregular, good scarlet color, moderately firm, quality fair. Plants vigorous, runners abundant. Not productive this season.

More Favorite, P. *From C. J. More, Jamestown, N. Y.* Blossoms with Beder Wood. Fruit small to medium, roundish, good scarlet color, moderately firm, good quality. Resembles the common wild strawberry but is somewhat larger and more productive. Plants very vigorous with abundant runners.

Morgan No. 1, S. *From J. A. Morgan, Scottsville, N. Y.* A seedlings of Sharpless by Triomphe de Gand. Plants vigorous, runners abundant, fruit stems medium length, erect. Fruit large to very large, irregular, good scarlet color, moderately firm, quality good. Not productive this season but considered worthy of further testing on account of size and appearance.

Noland, S. *From J. P. Noland, Peninsula, Ohio.* Fruit large to very large, irregular in shape, good scarlet color, moder-

ately firm, fair quality. Plants vigorous, runners abundant, fruit stems short. Only moderately productive this season.

OCEAN CITY, S. *From Slaymaker & Son, Dover, Del.* Plants vigorous, runners abundant, fruit stems short and erect. Fruit large, irregular, dark scarlet color with light flesh, moderately firm, quality good. Only moderately productive this season but considered worthy of further testing on account of its fine appearance and good quality.

OMEGA, P. *From Thompson's Sons, Rio Vista, Va.* Blossoms with Sharpless. Plants vigorous, runners abundant, fruit stems medium length, erect. Fruit medium to large, roundish, good scarlet color, firm, quality good. Ranks third in productiveness among all the varieties fruited on the station grounds this season.

OSWEGO QUEEN, S. *From M. Stevens, Pennelville, N. Y.* Fruit large, irregular conic, good scarlet color, firm, good quality. Plants vigorous, runners abundant, fruit stems long and erect. Ranks second in productiveness among all the varieties fruited this season and second in the amount of late fruit produced. Worthy of further testing where a late variety is desirable.

PARIS QUEEN, S. *From W. F. Allen, Salisbury, Md.* Plants moderately vigorous and fair plant makers, fruit stems medium length, erect. Fruit medium to large, conical to wedge shape, good scarlet color, rather soft, quality good. Moderately productive this season.

PLOW CITY, S. *From Slaymaker & Son, Dover, Del.* Plants vigorous and produce a moderate amount of runners, fruit stems long and erect. Fruit large, irregular, good scarlet color, firm, good quality. Unproductive this season.

PREMIUM, P. *From M. Crawford, Cuyahoga Falls, Ohio.* Blossoms with Sharpless. Fruit medium to large, roundish, good scarlet color, firm, good quality. The plants were small and weak with but few runners. The yield was necessarily low.

PRIDE OF CUMBERLAND, S. *From Slaymaker & Son, Dover, Del.* Fruit medium to large, roundish conic, good scarlet color,

firm, good quality, sweet. Runners abundant, plants moderately vigorous, fruit stems medium length. Unproductive this season. A large double calyx gives the berries a handsome appearance.

RIDGEWAY, S. *From L. J. Farmer, Pulaski, N. Y.* Plants very vigorous with abundant runners, fruit stems long and erect. Fruit large, roundish, dark scarlet color, firm, excellent quality. Ranks eighth in productiveness this season. Worthy of further testing on account of vigor of plants and quality of fruit.

RURAL GEM, S. *From J. H. Pease & Son, Thompsonville, Conn.* Fruit medium size, roundish conic, light scarlet color, moderately firm, quality fair, runners abundant, plants moderately vigorous, fruit stems medium length, erect. Ranks sixth in productiveness among all varieties fruited this season and first in the amount of late fruit produced. Recommended for further testing as a late variety.

SAMPLE, P. *From C. S. Pratt, Reading, Mass.* Blossoms with Sharpless. Fruit large, conic, good scarlet color, attractive, firm, good quality. Plants strong, with abundant runners, fruit stems medium length, erect. Ranks fifth in productiveness among all varieties fruited on our grounds this season. Worthy of further trial as a midseason berry.

SEAFORD, P. *From L. J. Farmer, Pulaski, N. Y.* Blossoms with Sharpless. Plants moderately vigorous with a fair amount of runners, fruit stems medium, prostrate. Fruit large, irregular conic, dark scarlet color, firm, fair quality.

Slaymaker No. 1, P. *From Slaymaker & Son, Dover, Del.* Blossoms with Beder Wood. Plants fairly vigorous, runners moderately abundant, fruit stems short and erect. Fruit medium to very large, varies from wedge to conic in shape, good scarlet color, moderately firm, quality fair, unproductive this season.

Slaymaker No. 9, S. *From Slaymaker & Son, Dover, Del.* Fruit large, roundish conic, light scarlet color, soft, poor quality. Plants vigorous and good plant makers, fruit stems short and erect. Unproductive this season.

SPARTA, S. *From J. H. Pease & Son, Thompsonville, Conn.* Fruit medium to large, roundish to conical with a slight neck, dark scarlet color, firm, good quality, sweet. Plants only moderately vigorous, runners abundant, fruit stems medium length, erect. Unproductive this season.

STAHELIN, P. *From F. C. Stahelin, Bridgman, Mich.* Blossoms with Beder Wood. Plants vigorous and good plant makers, fruit stems long and erect. Fruit medium or above, roundish conic, good scarlet color, moderately firm, quality good. Ranks second in productiveness among all the varieties fruited on the Station grounds in 1898, and first in the amount of early fruit produced. Recommended for trial as an early variety.

SUNRISE, P. *From W. F. Allen, Salisbury, Md.* Blossoms with Beder Wood. Fruit medium or above in size, roundish, good scarlet color, moderately firm, quality fair. Runners moderately abundant, plants fairly vigorous, fruit stems short and erect. Unproductive this season.

TENNYSON, S. *From Harrison's Nurseries, Berlin, Md.* Resembles Evans so closely that the same description will do for both.

VERA, P. *From E. B. Stevenson, Lawville, Canada.* Blossoms with Beder Wood. Runners moderately abundant, plants fairly vigorous, fruit stems short and erect. Fruit medium size, conical, good scarlet color, firm, good quality. Moderately productive this season.

WESTON, P. *From Thompson's Sons, Rio Vista, Va.* Blossoms with Sharpless. Runners moderately abundant, plants fairly vigorous, fruit stems medium length. Fruit medium to large, irregular conic, light scarlet color, moderately firm, quality poor. Not productive this season.

TABLE I.— LIST OF STRAWBERRIES FRUITED IN ONE-YEAR-OLD BEDS WITH A COMPARATIVE STATEMENT OF THE EARLY AND LATE YIELD OF EACH VARIETY.

Rank as to yield. 1898	Name of variety.	Yield of 22 feet of row.	Crop picked before June 17.	Crop picked after June 27.
		Ozs.	Per ct.	Per ct.
1......	Anlo	264	2	9
2......	Stahelin	250	36	3
3......	Omega	227	2	7
4......	Michigan	216	00	32
5......	Sample	204	13	8
6......	Rural Gem	201	00	40
7......	McKinley	196	10	15
8......	Ridgway	195	4	11
9......	Clyde	194	24	00
10......	Captain Jack	189	7	12
11......	Vera	186	25	3
12......	Henry	181	9	7
13......	Oswego Queen	175	00	44
14......	Noland	158	16	2
15......	Isabella	151	20	3
16......	Ocean City	138	10	12
17......	Paris Queen	134	25	4
17......	Evans	134	3	8
18......	Ganargua	130	13	3
19......	Ideal	128	20	2
20......	Tennyson	127	11	12
21......	Atlantic	125	00	19
22......	Carrie	122	00	19
22......	Hall Favorite	122	26	4
23......	*Slaymaker No.* 9	121	7	7
24......	Weston	118	12	1
25......	Bouncer	106	11	15
26......	*Morgan No.* 1	105	3	2
27......	*Slaymaker No.* 1	99	16	5
28......	More Favorite	91	31	00
29......	Plow City	90	00	22
30......	Minneola	82	7	5
31......	Sunrise	79	38	00
32......	Clarence	78	00	24
33......	Pride of Cumberland	76	00	10
34......	Anna Kennedy	67	40	00
35......	Edith	64	00	32
36......	Gardner	63	23	00
37......	Earliest	59	71	00
38......	Seaford	46	41	00
39......	Sparta	39	33	00
40......	Premium	36	00	17

EARLY VARIETIES.

June 17 has been assumed to be the beginning of midseason for this locality in 1898. By referring to Table 1 we find that eight varieties produced a fourth or more of their crops before June 17. These berries may be called early for this season. They are given below in Table 2.

TABLE II.— EARLY VARIETIES RANKED ACCORDING TO YIELD BEFORE JUNE 17.

Name of variety.	Date of first picking.	Yield before June 17.	Total yield, 1898.	Rank as to total yield, 1898.
		Ozs.	Ozs.	
Stahelin	June 11	90	250	2
Earliest	June 9	42	71	36
Hall Favorite	June 11	32	122	20
Sunrise	June 1	30	79	29
More Favorite	June 13	28	91	26
Anna Kennedy	June 11	26	67	33
Seaford	June 15	19	46	37
Sparta	June 9	13	39	38

Judging from the results of one season's test Stahelin can be recommended for trial not only as an early berry of merit but as a productive variety as well. Earliest and Sparta gave their first pickings two days earlier than Stahelin, but the amounts were small in each case and the rank as to total yield of both varieties is very low. Of the remaining varieties that are classed as early Hall Favorite was the most productive.

LATE VARIETIES.

Assuming that June 27 was the close of the midseason we find that 4 varieties produced 30 per cent or more of their fruit after this date. These are given below in Table 3.

TABLE III.— LATE VARIETIES RANKED ACCORDING TO YIELD AFTER JUNE 27.

Name of variety.	Date of last picking.	Yield after June 27.	Total yield, 1898.	Rank as to total yield.
		Ozs.	Ozs.	
Rural Gem	July 5	80	201	6
Oswego Queen	July 7	77	175	13
Michigan	July 11	69	216	4
Edith	July 5	19	64	34

Of the above varieties Rural Gem, Oswego Queen and Michigan can be recommended for trial where late berries are desired.

BLACK RASPBERRIES.

TABLE IV.— LIST OF BLACK RASPBERRIES FRUITED IN 1898 WITH A COMPARATIVE STATEMENT OF THE PERCENTAGE OF EARLY AND LATE YIELD OF EACH VARIETY.

Rank as to yield, 1898.	Name of variety.	When set.	Yield of row 25 feet long.	Crop picked before July 6.	Crop picked after July 15.	Canes winter killed.
1....	Pioneer	1895, fall....	484	34	15	5
2....	Palmer	1895, fall....	454	39	12	5
3....	Hilborn	1895, fall....	441	11	31	10
4....	Mohler	1895, fall....	440	24	15	2
5....	Older	1895, fall....	425	4	15	2
6....	Black Diamond..	1896, spring.	408	5	34	10
7....	Mills	1895, fall....	406	4	40	15
8....	Hopkins	1895, fall....	392	24	18	10
9....	Onondaga	1895, fall....	340	6	8	5
10....	Lawrence	1896, spring.	318	37	7	5
11....	Ohio	1895, fall....	306	4	28	2
12....	Kansas	1895, fall....	272	19	7	10
13....	Carman	1895, fall....	266	24	16	3
14....	Haynes	1895, fall....	259	6	15	5
15....	Lovett	1895, fall....	236	34	15	10
16....	*Poscharsky No.* 9..	1895, fall....	217	38	7	1
17....	Cromwell	1895, fall....	210	62	00	10
18....	Progress	1896, spring.	207	27	19	5
19....	*Babcock No.* 3	1895, fall....	183	00	26	10
20....	*Babcock No.* 5	1895, fall....	181	11	33	15
21....	Eureka	1895, fall....	149	22	16	2
22....	Manwaring	1895, fall....	121	19	8	5

EARLY BLACK RASPBERRIES.

Assuming that midseason began on July 6 all varieties that bore a considerable portion of their fruit before this date may be called early for this season. Table 5 shows that 5 varieties yielded 30 per cent or more of their crop before July 6. They are given below in Table 5.

TABLE V.— EARLY BLACK RASPBERRIES ARRANGED ACCORDING TO THEIR YIELD BEFORE JULY 17.

Name of variety.	Date of first picking.	Yield before July 6.	Total yield.	Rank as to total yield.
		Ozs.	Ozs.	
Lawrence	June 30	118	318	10
Palmer	June 30	177	454	2
Pioneer	June 30	165	484	1
Cromwell	June 27	130	210	17
Poscharsky No. 9	June 29	82	217	16

Palmer is a well tested and standard early variety. Pioneer is a newer introduction but has been quite satisfactory on our grounds. This season it takes first rank as to total yield and stands second in the amount of early fruit produced. Cromwell is well liked in many localities as an early berry. Lawrence was mentioned in last season's report as being worthy of farther testing. It was only moderately productive this year. *Poscharsky No. 9* is no improvement over many known sorts.

LATE BLACK RASPBERRIES.

The close of midseason for black raspberries may be regarded as occurring on July 15. All varieties that bore a fourth or more of their fruit after this date may be called late. These varieties are arranged below in Table 6.

TABLE VI.— LATE BLACK RASPBERRIES ARRANGED ACCORDING TO THEIR YIELD AFTER JULY 15.

Name of variety.	Date of last picking.	Yield after July 15.	Total yield.	Rank as to total yield.
		Ozs.	Ozs.	
Mills	July 27	162	406	7
Black Diamond	July 25	139	408	6
Hilborn	July 27	137	441	4
Ohio	July 25	86	306	11
Babcock No. 3	July 25	48	183	19

Of the above varieties all save Black Diamond have received favorable mention in several former bulletins. The canes of Black Diamond are very large and vigorous but the fruit is not as large and perfect as could be desired.

RED RASPBERRIES.

TABLE VII.—LIST OF RED RASPBERRIES FRUITED IN 1898 WITH A COMPARATIVE STATEMENT OF THE PERCENTAGE OF EARLY AND LATE YIELD OF EACH VARIETY.

Rank as to yield 1898.	Name of variety.	When set.	Yield of matted row 25 feet long.	Crop picked before July 7.	Crop picked after July 22.
1......	Loudon	1895, fall....	531	2	12
2......	Pomona	1895, fall....	443	36	2
3......	Royal Church	1895, fall....	441	00	21
4......	Kenyon	1895, fall....	425	00	17
5......	Pride of Kent	1895, fall....	417	24	4
6......	King	1895, fall....	392	8	7
7......	Marlboro	1895, fall....	388	34	2
8......	I. X. L.	1895, fall....	370	30	8
9......	Talbot	1895, fall....	338	00	38
10......	Townsend	1895, fall....	319	19	1
11......	*Koch No.* 1	1896, spring.	290	12	12
12......	Cuthbert	1895, fall....	288	0	26
13......	Superb	1895, fall....	282	00	29
13......	Unknown	1895, fall....	282	7	10
14......	Cline	1895, fall....	272	60	00
15......	English Giant	1895, fall....	238	00	31
16......	Turner	1896, spring.	230	16	7
17......	Naomi	1895, fall....	221	3	13
18......	Miller Woodland ...	1895, fall....	201	3	18
19......	Miller	1895, fall....	186	2	15
20......	Brandywine	1895, fall....	183	1	31
21......	Viking	1896, spring.	182	15	8
22......	Pride of Germany...	1896, spring.	171	00	6
23......	Phœnix	1896, spring.	169	2	16
24......	Superlative	1895, fall....	98	31	6
25......	Crimson Beauty ...	1895, fall....	82	2	11
26......	Olathe	1895, fall....	79	0	0

EARLY RED RASPBERRIES.

The greater portion of the crop of red raspberries was picked between the dates of July 7 and July 22. Those varieties that ripened a large share of their crop before July 7 may be called early for this season. Table 7 shows that four varieties ripened 30 per cent or more of their crop before this date. These have been arranged below in Table 8.

TABLE VIII.— EARLY VARIETIES ARRANGED ACCORDING TO THEIR YIELD BEFORE JULY 7.

Name of variety.	Date of first picking.	Yield before July 7.	Total yield.	Rank as to total yield.
		Ozs.	Ozs.	
Cline	June 27	163	272	14
Pomona	June 30	159	443	2
Marlboro	June 27	132	388	7
Superlative	June 30	30	98	25

Cline yielded a larger portion of its crop early than any other variety but its total yield is low and its fruiting season is comparatively short. Pomona and Marlboro are very similar in many respects but the former has always given a larger yield on our grounds. Superlative yields fruit of largest size but is very unproductive on our grounds.

LATE RED RASPBERRIES.

All varieties that yield 30 per cent or more of their crops after July 22, the date assumed as the close of midseason, have been classed as late for this season. They are given in Table 9.

TABLE IX.— LATE VARIETIES ARRANGED ACCORDING TO THEIR YIELD AFTER JULY 22.

Name of variety.	Date of last picking.	Yield after July 22.	Total yield.	Rank as to total yield.
		Ozs.	Ozs.	
Talbot	July 29	128	338	9
English Giant	August 1	74	238	15
Brandywine	August 1	57	183	20

Talbot is the only one of the above varieties that has been at all successful on our grounds and it has been only moderately productive.

BLACKBERRIES.

TABLE X.— YIELD OF BLACKBERRIES IN 1897.

Rank as to yield.	Name of variety.	When set.	Yield of row 25 feet long.	In marketable condition.	Canes winter killed.
			Ozs.		Per ct.
1....	Minnewaski	1895, fall....	637	July 20 to Aug. 24	2
2....	Ancient Briton...	1895, fall....	618	July 25 to Aug. 20	1
3....	New Rochelle ...	1895, fall....	583	July 18 to Aug. 17	1
4....	Success	1895, fall....	566	July 20 to Aug. 24	2
5....	Snyder	1895, fall....	507	July 20 to Aug. 10	0
6....	Stone Hardy	1895, fall....	480	July 25 to Aug. 20	1
7....	Mersereau	1895, fall....	417	July 18 to Aug. 10	1
8....	Ohmer	1895, fall....	388	July 20 to Aug. 17	1
9....	Sable Queen	1896, spring.	369	July 25 to Aug. 24	1
10....	Taylor	1895, fall....	352	July 22 to Aug. 20	1
11....	Early Mammoth..	1896, spring.	335	July 20 to Aug. 15	2
12....	Dorchester	1895, fall....	334	July 20 to Aug. 10	1
13....	Early King	1895, fall....	332	July 12 to July 27	1
14....	Lovett	1895, fall....	327	July 25 to Aug. 15	1
15....	*Ford No.* 1..	1896, spring.	314	July 25 to Aug. 15	1
16....	Fruitland	1896, spring.	298	July 25 to Aug. 15	1
17....	Reyner	1895, fall....	295	July 20 to Aug. 15	1
18....	Agawam	1895, fall....	282	July 20 to Aug. 10	1
19....	Wachusett	1895, fall....	271	July 19 to Aug. 12	0
20....	Erie	1896, spring.	216	July 22 to Aug. 12	1
21....	Wilson, Jr.	1895, fall....	172	July 16 to Aug. 12	0
22....	Black Chief	1895, fall....	169	July 25 to Aug. 15	2
23....	Western Triumph.	1895, fall....	167½	July 20 to Aug. 20	0
24....	Child Tree	1895, fall....	91	July 20 to Aug. 8	5

NOTES ON VARIETIES.

Successful blackberry culture in New York resolves itself largely into a question of the hardiness of varieties planted; since

winter protection is given the canes in a comparatively few instances. Last winter the canes on the Station grounds, though unprotected, were but slightly injured by cold weather and as a result some of the more tender varieties made a better showing than they have done in former seasons.

The list of varieties given in Table 10 is not materially different from the list published in 1897, therefore any extended discussion of the different sorts need not be entered into here. In general it may be said that Ancient Briton and Agawam have been quite satisfactory on our grounds as regards hardiness and productiveness. Neither of them bear as large fruit, nor is it of as good quality as some of the less hardy varieties. Snyder is valuable because of its hardiness. Success and Mersereau are promising new varieties as they have been so far comparatively hardy and the fruit is of good size and quality. Early King is a satisfactory early berry. Minnewaski, New Rochelle and Dorchester are perhaps among the best of the varieties given in the table, but the plants are not always hardy in this locality.

NOVELTIES.

LOGAN BERRY.

Plants of this berry were received from A. Blanc, Philadelphia, Pa., in the spring of 1896. The plants made a satisfactory growth during the season, but though well protected the canes were killed to the ground during the following winter. Last winter, perhaps because of more thorough protection, the plants were uninjured and so bore their first fruit this season. The fruit is large, some specimens being an inch and a quarter long, bright red, turning to dark red when fully ripe, grains large, attached to a large core, quality good with flavor somewhat like an acid red raspberry. The berries are borne singly and in loose clusters so the plants can never be very productive. The canes are much like the dewberries in habit and require some support.

Judging from our experience with this fruit we cannot expect it to be grown with profit in this State.

STRAWBERRY-RASPBERRY.

These plants came from A. Blanc, Philadelphia, Pa., in 1895. Plants vigorous, about 2 feet high, spread rapidly by suckers. Fruit large, irregular in form, color red, poor quality, unproductive, entirely worthless as grown on our grounds.

IV. EXPERIMENTS IN RINGING GRAPE VINES.*

WENDELL PADDOCK.

SUMMARY.

Experiments in ringing grape vines were begun in 1896 and continued through two seasons. The first season the effect on the fruit of some varieties was very marked. Fruit on ringed vines of Empire State was not only larger in both bunch and berry, but began ripening 21 days before fruit of unringed vines. Other varieties did not show any gain in size or earlier maturing of the fruit when ringed.

The fruit of some varieties, as the Delaware, showed a lack of quality when ringed, while thin-skinned varieties, as the Worden, showed a greater tendency to crack when grown on ringed vines.

The second season the effect of ringing was not nearly so marked thus showing that the season has something to do with results obtained.

That the effect of ringing is devitalizing to the plant there can be little doubt, but when judiciously managed the cumulative effect on strong growing varieties need not result disastrously.

INTRODUCTION.

Briefly stated, the operation of girdling, or more properly speaking, ringing, grape vines consists in removing a ring of bark from the bearing arm about an inch wide or wide enough so that the bark will not heal over the wood that has been laid bare.

*** Reprint of Bulletin No. 151.**

The effect sought in ringing is to produce earlier ripening of the fruit and larger bunches and berries. The explanation of this effect on the fruit is readily found when the movement of the food within the plant is understood. The food materials taken in by the roots pass up through the outer layers of wood to the green parts of the plant. Here new material for growth is formed and the portion that is not needed by the leaves and other green parts passes downward, for the most part through the inner bark, to be be distributed wherever it is needed. The wood is not disturbed in the process of ringing, therefore the upward movement of the solutions is not interfered with; but since the downward passage takes place through the inner bark the flow is arrested when it arrives at the point where the bark has been removed. Consequently the parts of the plants that are above the point where the ring of bark has been removed receive more than a normal supply of food, which tends to produce increase in size and earlier ripening of the fruit.

It will be seen that the food that passes into the ringed arms is mostly lost so far as building up the plant itself is concerned, hence the operation must result in a drain on the plant's vitality. However, in localities where ringing is extensively practiced, vineyards are freqently pointed out that have been ringed 10 or 15 years in succession and are still yielding paying crops. Growers have learned to do the work intelligently. For instance, where the vines are grown on the two-arm Kniffin system the ring of bark is commonly taken from both arms just beyond the fifth bud. It has been found that the ten buds that are left to the vine produce enough leaf surface to supply the food necessary to keep the vine in a vigorous condition, providing the vineyard has received proper care. Where the four-arm Kniffin system is used some growers ring the two top arms only, leaving three or four buds on each for renewal. The two lower arms, it is claimed, will bear as good fruit as adjacent vines that have not been ringed. With the

renewal system the two main arms are usually ringed just beyond the renewal bud. With this system of training several shoots are left in the center of the plant which supply a sufficient amount of plant food to support the vine. Some growers find it more satisfactory to ring their vines every other year, since with this method the vines are given an opportunity to recover from any loss of vigor they may have suffered.

With any system of training, in order to get the best results, the vines must not be allowed to carry too large a crop of fruit. Since each ringed arm acts independently so far as maturing its fruit is concerned it will be seen that there is a certain relation between the leaf surface and the amount of fruit on the ringed vine. A large amount of fruit with insufficient leaf surface on the ringed arms results in inferior or even worthless grapes; hence the importance of an abundance of foliage free from plant disease and insect attack. It is equally important that there be an abundance of healthy foliage back of the rings in order to supply the plant with sufficient nourishment to keep it in a vigorous condition. All fruit back of the rings should be removed, for if allowed to remain it does not properly mature and only adds a useless drain on the plant's vitality.

The increase in size and early maturing of the fruit is commonly thought to take place at the expense of quality and firmness. Our experience goes to show that this is true of some varieties; whether or not it is a general principle is not so clear.

Fruit from ringed Delaware vines in our experiments was found to lack much of the fine quality that is characteristic of this variety. On the other hand the loss of quality was not noticeable in some of the less delicately flavored sorts. The fruit of those varieties that crack easily, as the Worden, was found to be more marked in this characteristic when grown on ringed vines.

Growers have found that the best results with ringing are obtained by doing the work when the grapes are about one-third grown; the exact time depending on the season and variety. The

operation may be performed with a knife, but where ringing is extensively engaged in a tool designed for the purpose is used.

In order to obtain some definite data on the subject of ringing grape vines experiments were begun in 1896 in two sections of the State. The results of the experiments as given in the following pages are not all conclusive, but are offered as a confirmation of some of the knowledge that the growers have gained.

EXPERIMENTS AT POUGHKEEPSIE.

Experiments in ringing grape vines were begun in the vineyard of Mr. Walter F. Taber, Poughkeepsie, N. Y., in 1896, and continued through two seasons. Different varieties were selected for the experiment and since Mr. Taber trains his vines on the two-arm Kniffin system both arms of all vines save four were ringed just beyond the fifth bud. With the remaining four vines both arms were ringed just beyond the renewal bud.

All vines were ringed June 20. Notes were taken on the condition of the fruit August 20 as follows:

Concord.— A remarkable difference in the condition of the fruit on the ringed and unringed vines. The fruit on the former vines is much farther advanced, though not yet ripe.

Delaware.— Not much difference in size or earliness but the quality of the fruit on the ringed vines is decidedly inferior to that on unringed vines.

Empire State.— Fruit on ringed vines is now about ripe. Nearly two weeks earlier in ripening than the unringed vines.

Moore's Early.— No noticeable difference between the fruit on ringed and unringed vines, though the berries of the former are a little larger and not as good in quality.

Niagara.— Fruit on ringed vines is somewhat larger and somewhat earlier, not yet ripe.

Worden.— Fruit on ringed vines a little earlier but no larger, more inclined to crack than fruit from unringed vines.

The following table is taken from a letter from Mr. Taber, which gives the season of ripening of the fruit on the ringed and unringed vines of the different varieties for 1896:

	Began picking.	Maturity advanced by ringing.
		Days.
Concord, ringed	September 4....	17
Concord, unringed	September 21....	17
Delaware, ringed	August 24....	9
Delaware, unringed	September 2....	9
Empire State, ringed	August 25....	21
Empire State, unringed	September 15....	21
Moore's Early, ringed	About same time.	00
Moore's Early, unringed	About same time.	00
Niagara, ringed	August 27....	14
Niagara, unringed	September 10....	14
Worden, ringed	About same time.	00
Worden, unringed	About same time.	00

No difference was noticed during the season between the vines that were ringed beyond the fifth bud and those that were ringed beyond the renewal bud.

In 1897 it was the intention to ring the same vines and in the same manner. The result is best given by an extract from a letter from Mr. Taber under the date of November 3, 1897:

The same vines were girdled as last year excepting the two vines of Niagaras, one of which was dead and the other died soon after leafing out; these vines you will remember were girdled back to the renewal bud. This is evidently more than the vine can stand.

The effects this year were not as pronounced as last year. The fruit on girdled vines commenced coloring earlier than the others, but when it was fit to cut there were bunches on ungirdled vines that were just as near ripe. One kind only, the Empire State, was improved in size and hastened somewhat in ripening, but changed more in size than in time of ripening.

EXPERIMENTS AT LODI.

The experiments at Poughkeepsie were duplicated in the vineyard of E. Smith and Sons, Lodi, N. Y. Mr. Smith trains his vines on the renewal system and as there are several shoots allowed

to grow up in the center where none grow on vines trained on the Kniffin system the ring may be made closer to the renewal bud with less danger of injuring the vine. This is due to the larger amount of leaf surface left to build up the vine when trained on the renewal system.

In these experiments the ring was made just beyond the renewal bud. All vines were ringed June 29, 1896. The following notes were taken August 29:

Concord.—Bunches are noticeably larger and more compact, with larger berries on the ringed vines; now ripe. Two vines had but one arm ringed; the bunches on these arms are larger and compact while on the unringed arms on the same vine the clusters are small, loose and unripe.

Catawba.— Fruit on ringed vines will evidently be quite a little earlier.

Delaware.— Fruit quite a little larger in bunch and berry but no earlier in ripening and not as good in quality as on unringed vines.

Geneva.— Was able to pick out the ringed vines by the appearance of the fruit. The bunches on these vines were uniformly large and compact. Berries a little larger but much poorer in quality, quite sour as compared with fruit on unringed vines.

Niagara.— Bunch and berry on ringed vines are larger and finer in appearance; a little earlier in ripening. Not as good in quality, more acid than fruit on unringed vines.

In 1897 the ends of the ringed canes on part of the vines were cut back in order to see if this would make any difference in the quality of the fruit, the theory being that if the food required by the new growth could be made available to the fruit it would tend to produce better quality.

All vines were ringed June 29. The following notes were taken September 1:

Champion.— Bunch and berry at least one-third larger than on unringed vines.

Catawba.— Fruit on ringed vines is at this date a half larger and well colored. On unringed vines the grapes are still green.

Geneva.— Bunches on ringed vines are at least one-fourth larger and ten days ahead in ripening. Bunches much better filled out and nicer in appearance.

Notes were again taken on September 11, and at this date there was not so much difference to be seen between the fruit of the ringed and unringed vines. The weather had been very dry and hot, which may in a measure account for such results.

Champion.— The fruit of this variety shows about the same difference on ringed and unringed vines as was noted on September 1.

Catawba.— This variety alone shows a striking difference. Grapes on ringed vines are now nearly ripe while on the unringed vines the berries are just beginning to turn.

Geneva.— The bunches on ringed vines are at least a third larger, more compact and better filled out. But little difference in the period of ripening.

Niagara.— Bunches and berries on ringed vines somewhat larger than on unringed vines but not a marked difference.

The fruit on the ringed vines that were cut back seems to be somewhat better in flavor and quality than that on untrimmed vines. Fruit of Concord and Geneva, especially, on the trimmed vines does not have so much of the acid taste which is so noticeable in fruit from untrimmed vines.

RÉSUMÉ.

1. Ringing grape vines, generally speaking, produces an earlier ripening of the fruit and larger bunches and berries.

2. These results, however, depend on several factors, among which may be mentioned: Variety, season, an abundance or lack of healthy foliage, good culture or lack of it, and the amount of fruit the vine is allowed to mature.

Plate XLVII.—Fig. 1. Fruit of Empire State from Ringed Vine; 2. From Unringed Vine; 3. From Ringed Vine Back of Ring. Photographed Aug. 21, 1896.

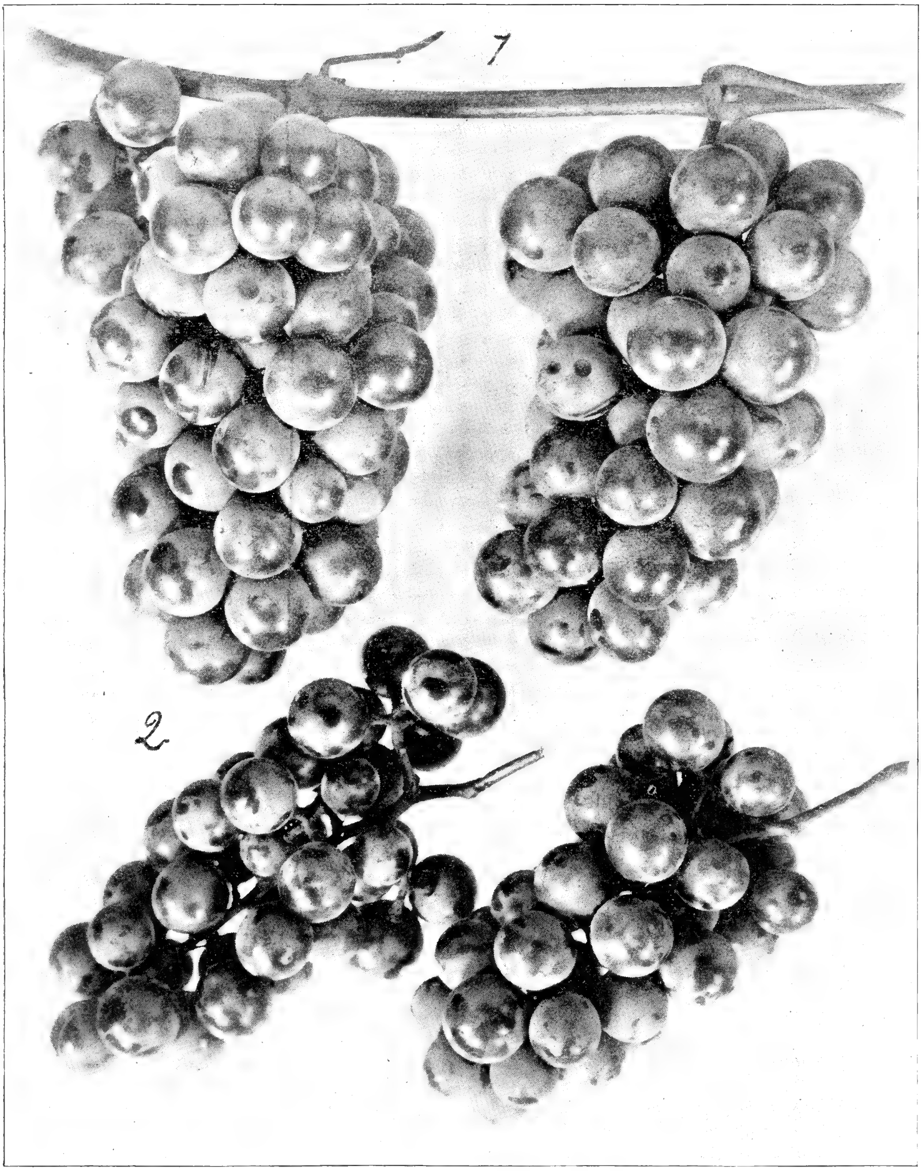

PLATE XLVIII.—FIG. 1. FRUIT OF NIAGARA FROM RINGED VINE; 2. FROM UNRINGED VINE. PHOTOGRAPHED SEPT. 1, 1897.

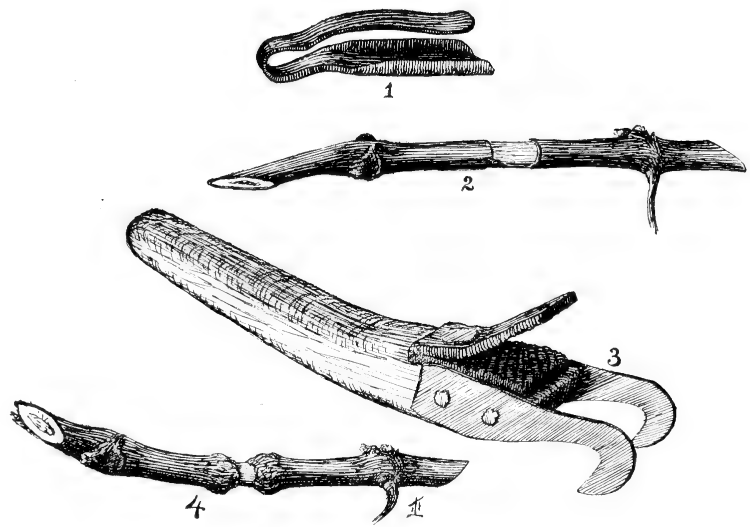

Fig. 7.—1 and 3. Tools Used in Ringing Grape Vines; 2. Vine Showing Ring of Bark Just Removed; 4. Same at Close of Season.

3. That some varieties suffer a loss of quality when ringed there is little doubt; other varieties do not appear to be affected in this manner by the operation. Cutting back the new growth on ringed arms appeared to result in giving better quality to the fruit.

4. The process is more or less devitalizing in its effect on the vine, depending in part at least, on the factors mentioned in the second paragraph. It has been found in practice, however, that some varieties when judiciously managed may be ringed for a number of years in succession with little injury to the vine.

5. Vines grown on the renewal system would seem to be better adapted to ringing than those grown on the Kniffin plan, since with the former more wood can be left to support the vine than is possible with the latter system.

V. SELF-FERTILITY OF THE GRAPE.*

S. A. BEACH.

SUMMARY.

Cultivated American grapes show remarkable differences in the degree of self-fertility of different varieties. Many of them fruit perfectly of themselves. Others form no fruit when cross pollination from other varieties is prevented. Most varieties are found between these two extremes, being neither fully self-fertile nor completely self-sterile.

With many varieties the degree of self-fertility is not an unchangeable characteristic, even when the vines appear to be in a normally productive condition; but varies under differences of environment. Many other varieties which have been under observation show practically no variation in this respect. Usually when any variation in self-fertility is observed with a variety it is confined within rather narrow limits. In exceptional cases rather wide variations are seen.

Investigations to determine the degree of self-fertility of a variety should be made with vines in a normally productive condition because variations in the amount of fruit which sets may be due to an unproductive condition of a portion or all of the vine. It is desirable, also, that a large number of clusters be tested for each variety and that the tests be made in more than one locality and in more than one season.

One hundred and sixty-nine cultivated varieties were included in these investigations. They are classified, according to the de-

* Reprint of Bulletin No. 157.

gree of self-fertility which they have shown in these tests, into four lists which are given in full in the body of the report. Class 1 includes self-fertile varieties having perfect clusters or clusters varying from perfect to somewhat loose. Class 2 includes self-fertile varieties having clusters loose but marketable. Class 3 includes varieties which are so imperfectly self-fertile that the self-fertilized clusters are generally too loose to be marketable. Class 4 includes the self-sterile varieties. Whenever cross-pollination has been prevented these have developed no fruit.

The varieties named in Classes 1 and 2 form marketable clusters from self-pollinated blossoms and may be planted alone. Those which are named in Classes 3 and 4 should be planted near other varieties which bloom at the same time because when cross-pollination is prevented they either produce no fruit or the clusters which develop are too loose to be marketable. Lists showing the period of blooming of most of these varieties are given in this report.

The method of testing grapes as to self-fertility by covering the clusters during the blooming season to prevent cross-pollination is certainly reliable with varieties which have long stamens, and apparently so with all other varieties.

Short or recurved stamens are always found associated with complete or nearly complete self-sterility.

Long stamens are not a sure indication of self-fertility because some varieties which have long stamens are self-sterile.

The most satisfactory explanation of the self-sterility which exists among grapes appears to be that there is a lack of affinity, in the self-sterile varieties, between the pollen and the pistils of the same variety.

HISTORY OF INVESTIGATIONS.

Investigations concerning the self-fertility of grapes were begun at this Station in 1892 and the work has been continued till the present time. These tests have included twelve American species, together with many of their hybrids with each other and

with the European species which are found among the cultivated varieties. One hundred and sixty-nine cultivated varieties have been under test. The tests have mostly been made in Station vineyards, but vineyards in two other localities have also been under investigation. In many cases the same variety has been tested in more than one season and in two or three localities.

Reports of progress have appeared from time to time in the Station's Annual Reports and in papers prepared by the author for horticultural or scientific societies.[1] Since the circulation of the Annual Reports among the fruit growers is somewhat limited this account of the investigations is presented in bulletin form. It includes much that has not previously been published and is complete to date. The work has been extended year by year till all the standard amateur and commercial varieties of this State, and also many new or little known varieties, have been tested.

Previous to the undertaking of these investigations, but little was definitely known concerning self-sterility among cultivated American grapes. The opinion had occasionally been advanced that with certain varieties, especially with some of the Rogers hybrids, cross-pollination[2] was an advantage if not absolutely essential to the production of fruit. It had been observed that such varieties fruited imperfectly or were perhaps absolutely barren when standing alone, but gave much better results when they were located adjacent to other kinds of grapes. Although these things had attracted the attention of a few careful observers they were not made the

[1] Eleventh Annual Rep. N. Y. Agrl. Exp. Station, 1892: 597–606.

Thirteenth Annual Rep. N. Y. Agrl. Exp. Station, 1894: 636–648.

Fourteenth Annual Rep. N. Y. Agrl. Exp. Station, 1895: 320–325.

Notes on Self-pollination of the Grape. Rochester Meeting A. A. A. S., 1892; Garden and Forest, 1892: 451, 452.

Fertilization of Flowers in Orchard and Vineyard. Annual Meeting Ontario Fruit-Growers' Assn., Orillia, Canada, 1894.

Notes on Self-fertility of Cultivated Grapes. Boston Meeting S. P. A. S., 1898: American Gardening, 19: 666 (1898).

[2] The term "cross pollination" is used in this report to designate the conveying to a pistil of pollen from another variety rather than from other vines of the same variety.

subject of systematic investigation until the work by the writer at this Station showed that self-sterility, either absolute or to a considerable degree, is found with a large number of cultivated American grapes.

METHODS OF INVESTIGATIONS.

THE VINES.

The vines which have been used in these investigations have been generally thrifty, vigorous and in a normally productive condition.

The Station vineyards, in which most of the work has been done, are on a fertile clay loam which favors a strong growth of vine. Some weak kinds, like Rebecca, have not made a good growth, but most of the varieties are probably stronger growers here than they are on the average on land better suited for vineyard purposes and especially for developing high flavor in the grape.

Although the vines in these vineyards generally make good growth, they are seldom too vigorous to yield well. Some idea of the yield that may be expected from productive varieties on this soil may be gained from the following statement of the annual yield per vine of Worden in a Station vineyard.

Six Worden vines planted in the fall of 1892 yielded their first fruit in 1895, averaging about half a pound per vine. In 1896, the fourth season after planting, the yield was 11.63 pounds; in 1897, 23.38 pounds; and in 1898, 18.31 pounds per vine.

COVERING THE CLUSTERS.

In testing a variety for self-sterility the clusters which have been selected for the test are covered with paper bags before the blossoms open. This excludes outside pollen so that if pollination takes place the pistil must either receive pollen from its own blossom or from some other blossom in the same cluster. Ordinary manila paper bags obtained from the grocer have been used, the

3-pound to 5-pound sizes being preferred. The smaller sizes may cramp the larger clusters and the larger sizes offer too much resistance to the wind. The shoots on which the clusters are borne being still green and tender at blooming time are more liable to be broken off in wind storms when the large bags are attached to them than they are when the smaller sizes are used.

In preparing a bag for covering a cluster it is slit downward from the mouth for a short distance on opposite sides so that the open end may include and project beyond the shoot on which the cluster is borne as shown in Figure 1. The mouth is then closed and fastened with a wired label as shown by Figure 2. In this way a portion of the shoot is included which holds the bag more firmly than when it is fastened to the stem of the cluster only and the cluster is less apt to be broken off.

NUMBER OF VINES AND CLUSTERS TESTED.

Number of clusters.— The number of clusters tested among the cultivated grapes varies from four to seventy-one and averages about fifteen to the variety. This does not include the varieties Little Blue, Norfolk and Illinois City. No account is taken of clusters which have been lost or destroyed by accident.

Number of vines.— No exact record has been kept of the number of vines tested to the variety. It varies from one to perhaps ten or more. Probably in the majority of cases at least two vines have been tested to the variety.

Tests of but few clusters.— Are tests of two or three clusters on a single vine sufficient to show the characteristic degree of self-fertility of a variety? The records of these tests give some evidence on this question. Nineteen varieties were tested by covering only two clusters of each in one season. The same varieties were afterwards tested by covering a larger number of clusters. The latter tests gave results practically similar to those of the first tests except in the case of three Rogers hybrids which in the first tests gave only perfect clusters and in the later tests gave some

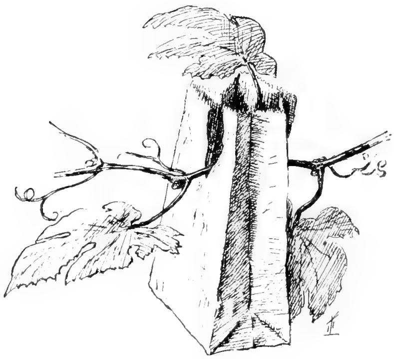

FIG. 8.—BAG IN POSITION—OPEN.

FIG. 9.—BAG CLOSED WITH WIRED LABEL.

perfect or nearly perfect clusters and also some that were quite imperfect. It appears therefore that while tests with one or two clusters may generally give a good indication of the condition of a variety they are not extended enough to be received as conclusive. Indeed some kinds of grapes show much variability in the character of their self-fertilized clusters on the same vine, although the average results of the variety with different vines and in different tests are quite similar. In addition to the instances of the Rogers hybrids which have just been cited, detailed results in two other cases of this kind will be given as illustrating this feature in certain variable grapes. In 1897 9 clusters of Antoinette were covered during the blooming season. Three produced perfect clusters of fruit, 3 were almost perfect, 2 were rather loose and 1 formed no fruit. Had only the last-named cluster been tested Antoinette might have been listed as a self-sterile variety. Twenty-two clusters of Vergennes were tested at Penn Yan in 1897. Two clusters formed no fruit. The other twenty averaged about half filled, varying from the very loose and imperfect clusters shown in Plate XLIX, Figure 2, to the nearly perfect cluster which is shown in Figure 1.

Seasons and localities.— From a consideration of these results and others which will be presented on following pages it is clear that not only should more than one vine be included in tests of self-fertility, but the tests should be made in more than one season and under diverse conditions of soil and climate. This has not yet been done with all of the varieties which are included in these experiments. Of the 169 cultivated varieties under investigation but 78 have been tested by the writer in more than one season and only 24 in more than one locality.

METHODS OF RECORDING OBSERVATIONS.

When the fruit of uncovered clusters was nearly or quite full grown each covered cluster was examined. Whenever any fruit was found a record was made of the proportion of blossoms which

had developed into fruit. If no fruit, or none but abortive fruit developed, that fact was noted. Plate L illustrates a case of a variety which produced no fruit when self-pollinated. Plate LI, Figure 1, shows the results with a nearly self-sterile variety, while Plate LII shows how perfectly the covered clusters may develop when the variety is self-fertile to a high degree.

The degree of compactness of the uncovered clusters was also recorded in many cases, but unfortunately not in all. In the case of vines located at the Station the yield of the vine was recorded. In a few instances, after the blossoms had been covered the vines appeared to be in an unsatisfactory condition for the test as manifested by abnormal unproductiveness, injury, weakness, disease, too rampant growth or some other disqualifying feature. The records of such vines, if presented at all, are not included in making the final estimate upon which the classification of the variety as to its self-fertility is based. In some cases it has appeared doubtful whether the vine was in a proper condition for the test. When the final estimate is based on such tests it is marked as questionable.

RECORD OF RESULTS.

The results of the tests with each variety are set forth for each year and each locality in Table I. The number of clusters included in each test is stated and the kind of stamens is given except for a very few varieties with which no observations on this point have been made. For self-sterile varieties and for those in which the self-sterilized clusters were on the average too loose to be called marketable, the yield of the entire vine, or vines, as the case may be, is stated to show the degree of productiveness from uncovered clusters. In many cases where covered clusters have failed to fruit, or have fruited imperfectly, the same vine has given a fair, or even a good yield, from the uncovered clusters. This is accounted for by the fact that all of the vines included in these experiments have been located where cross-pollination could

occur. Plate LIII shows clusters of fruit thus produced by self-sterile varieties. Compare also Figure 1 of Plate LI with Figure 2 of the same plate. Figure 1 shows the best clusters and, excepting one berry, all of the fruit which Brighton has produced on covered clusters in these experiments. Figure 2 shows a cluster of the same variety which was exposed to cross-pollination.

Whenever self-sterile or nearly self-sterile varieties have produced a good yield from uncovered clusters it shows that the vine was in good condition for testing. On the other hand a scant yield, or even a total failure to produce fruit from uncovered clusters cannot be accepted as proof that the vine was in an abnormally unproductive condition and not suitable for testing because the prevalence during the blooming season of a damp, cold atmosphere or of other conditions unfavorable to cross-pollination would manifestly interfere with the setting of the fruit and reduce the yield. Moreover, either the tendency to great productiveness or the opposite tendency appears as a varietal characteristic among self-sterile as among self-fertile sorts. For example, Elvibach and Red Eagle are both self-sterile. In 1894 and again in 1895 Elvibach gave a very light crop, although located in a mixed vineyard where the clusters were exposed to cross-pollination. Red Eagle, in the same vineyard, and under similar treatment, gave a fair yield in 1894 and a very good yield in 1895. The Elvibach vines being mature and apparently in good health their failure to produce even a fair crop under the circumstances, together with the general record of the variety here, indicate that even were it not self-sterile it would be habitually a poor cropper.

The following table gives a list of varieties tested as to self-fertility and shows for each variety the kind of stamens, the number of clusters tested, the character of the covered fruit clusters and the character of the uncovered clusters of self-sterile varieties.

TABLE I.— CHARACTERISTICS OF GRAPE VARIETIES RELATING TO SELF-FERTILITY.

Name.	Kind of stamens.	Year of test.	Entire yield per vine.	Character of uncovered clusters.	Number of clusters tested.	Remarks on covered clusters.
Adirondack	long	1894	light	moderately compact.	10	Practically self-sterile; one cluster matured two berries.
Agawam	long	1892	——		10	Somewhat loose but marketable.
Aledo	long	1894	good	Well filled.	5	Self-sterile.
Alexander Winter	short	1895	very light	imperfect.	10	Very loose.
Alice	long	1894	fair		5	Somewhat loose but marketable.
Amber	long	1894	light	moderately compact.	5	Self-sterile. (?)
Amber Queen	short	1894	fair		10	Self-sterile. (?) Had one cluster of small seedless berries.
Ambrosia	long	1894	——	compact.	10	Perfect.
America	short	1895	good	well formed.	10	Self-sterile.
Aminia	short	1892	light	moderately compact.	2	Berries which set were all abortive.
Aminia	——	1898	fair	half filled.	9	Self-sterile.
Antoinette	long	1896	——		5	Nearly perfect.
Antoinette	——	1897	good		9	Somewhat loose but marketable.
Arkansaw	long	1896	——		10	Somewhat loose but marketable.
Bailey	long	1897	——		5	Somewhat loose but marketable.
Barry	short	1892	fair	somewhat loose.	2	Self-sterile.
Barry	——	1895	good	somewhat loose.	10	Self-sterile.
Barry	——	1898	good	nearly perfect to loose.	8	Self-sterile.
Beagle	short	1894	fair		10	One cluster matured four berries.
Berckmans	long	1896	——		4	Perfect.
Berckmans	——	1897	——		9	A little too loose to be marketable.
Berckmans	——	1898	——	perfect.	10	Somewhat loose but marketable.
Bertha	long	1895	——		5	Perfect.
Bertha	——	1897	——		4	Somewhat loose but marketable.
Big B. Con	long	1895	——		8	Somewhat loose but marketable.
Bix Extra	long	1897	——		10	Somewhat loose but marketable.

Big Hope	long	1897	good		4	About 60 per ct. of blossoms matured fruit.
Black Eagle	short	1892	fair		2	Had a few abortive berries.
Black Eagle	———	1895	fair	somewhat loose.	10	Self-sterile.
Blanco	short	1894	light	loose or mod. compact.	5	Self-sterile.
Blanco	———	1895	light		5	Self-sterile.
Brighton	short	1892	fair		9	None but abortive berries.
Brighton	———	1895	light		5	Self-sterile.
Brighton	———	1897	very good		27	Self-sterile.
Brighton *	———	1897	very good		25	Very few berries developed.
Brighton †	———	1897	very good		5	About 6 per ct. of blossom set and matured fruit.
Brilliant	long	1894	fair	moderately compact.	10	Moderately compact.
Brilliant	———	1894	———		5	Somewhat loose but marketable.
Brilliant	———	1895	———		10	Nearly perfect.
Brown	long	1896	———		5	Somewhat loose but marketable.
Burnet	short	1894	light	rather loose.	10	Self-sterile.
Burrows No. 42c	long	1894	———		9	Clusters compact.
Canada	long	1894	light	vary from compact to imperfect.	5	Clusters vary from compact to quite imperfect but average nearly as good as clusters not covered
Canonicus	long	1894	fair		5	About 20 per ct. set fruit.
Carman	long	1895	———		5	Not quite so compact as uncovered clusters being somewhat loose but marketable.
Catawba	long	1894	———		12	Nearly perfect.
Catawba *	———	1897	———		16	Somewhat loose but marketable.
Catawba †	———	1897	———		22	Somewhat loose but marketable.
Caywood No. 50	long	1894	———		4	Nearly perfect.
Centennial	long	1894	———	moderately compact.	9	Somewhat loose but marketable.
Champion	long	1894	light		10	Covered clusters formed no fruit, but the whole vine was unfruitful, and not in good condition for the test.

* Test made at Penn Yan, N. Y. † Test made at Branchport, N. Y.

TABLE I.— CHARACTERISTICS OF GRAPE VARIETIES RELATING TO SELF-FERTILITY — *Continued.*

Name.	Kind of stamens.	Year of test.	Entire yield per vine.	Character of uncovered clusters.	Number of clusters tested.	Remarks on covered clusters.
Champion	———	1895	fair		7	Somewhat loose but marketable.
Chandler	long	1895	———		7	Somewhat loose but marketable.
Chandler	———	1896	———	moderately compact.	5	Somewhat loose but marketable.
Chautauqua	long	1896	———		5	Somewhat loose but marketable.
Clevener	short	1894	fair	rather loose.	10	Self-sterile.
Clevener	———	1897	fair		8	Self-sterile.
Clinton	long	1894	———	moderately compact.	10	Somewhat loose but marketable.
Clinton †	———	1897	———		4	About forty blossoms matured fruit.
Colerain	long	1895	———		10	Somewhat loose but marketable.
Columbia	———	1897	———		8	Nearly perfect.
Concord	long	1892	———	moderately compact.	10	Moderately compact.
Concord *	———	1897	———		20	Somewhat loose but marketable.
Concord †	———	1897	———		11	Somewhat loose but marketable.
Cottage	long	1894	———	moderately compact.	5	Moderately compact.
Cottage	———	1897	———		5	Nearly perfect.
Creveling	short	1894	good	loose.	5	Self-sterile.
Creveling	———	1895	fair	somewhat loose.	5	Self-sterile.
Creveling†	———	1897	———		5	Self-sterile.
Croton	long	1894	———		10	Perfect.
Daisy	long	1894	light	loose.	5	Set only a few berries.
Daisy	———	1898	good		1	Neither covered clusters nor uncovered clusters set fruit. Vine not in good condition for the test.
Delaware	long	1892	———		10	Perfect.
Delaware *	———	1897	———		21	Somewhat loose but marketable.
Delaware †	———	1897	———		18	Somewhat loose but marketable.
Delaware	———	1898	———	compact.	1	Perfect.

Denison	long	1895	fair		5	Vine unfavorably located for the test, none but abortive berries formed.
Denison	——	1898	fair	loose.	10	About 50 per cent of blossoms matured fruit.
Diamond*	long	1892	——	perfect.	2	Perfect.
Diamond†	——	1897	——		15	Perfect.
Diamond	——	1897	——		18	Perfect.
Diana	long	1894	light		4	Somewhat loose but marketable.
Diana	——	1895	——		5	Perfect or nearly so.
Diana*	——	1897	——		10	Perfect.
Diana†	——	1897	——		5	About 56 per cent of blossoms matured fruit.
Dr. Collier	long	1895	good	well formed.	10	Perhaps 50 per cent of blossoms set fruit.
Dr. Collier	——	1898	——	nearly perfect.	3	Nearly perfect.
Dr. Hexamer	short	1895	fair	nearly perfect.	10	Self-sterile.
Dracut Amber	long	1894	light	moderately compact.	5	About one-third of covered blossoms set fruit.
Dracut Amber	——	1895	fair		2	One bunch perfect, 90 per cent of other bunch abortive.
Duchess	long	1894	light		10	Vine apparently not in good condition for the test. About 15 or 20 per cent of blossoms self-fertile.
Duchess*	——	1897	——		21	Nearly perfect.
Duchess	——	1898	good		14	Perfect.
Early Golden	long	1894	——		5	Perfect.
Early Golden	——	1895	——	compact.	5	Not quite so compact as uncovered clusters, being somewhat loose but marketable.
Early Market	long	1894	——	rather loose.	5	Somewhat loose but marketable.
Early Market	——	1895	——		5	Somewhat loose but marketable.
Early Ohio	long	1895	——		10	Somewhat loose but marketable.
Early Victor	long	1896	——		5	Somewhat loose but marketable.
Eaton	long	1894	good	moderately compact.	10	Self-sterile.

*Test made at Penn Yan, N. Y. †Test made at Branchport, N. Y.

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TABLE I.— CHARACTERISTICS OF GRAPE VARIETIES RELATING TO SELF-FERTILITY — *Continued.*

NAME.	Kind of stamens.	Year of test.	Entire yield per vine.	Character of uncovered clusters.	Number of clusters tested.	Remarks on covered clusters.
Edmeston No. 1	long	1895	———	somewhat loose.	9	Somewhat loose but marketable.
Eldorado	short	1894	no fruit		5	Self-sterile.
Eldorado	——	1895	‡no fruit		5	Self-sterile.
Eldorado	——	1897	———		23	Self-sterile.
Elsinburg	long	1894	———		10	Moderately compact; almost as compact as uncovered clusters.
Elvibach	short	1894	very light	compact.	5	Self-sterile.
Elvibach	——	1895	very light	compact.	10	Self-sterile.
Elvira	long	1894	———		5	Nearly perfect.
Empire State	long	1894	———	not very compact.	10	A little less compact than uncovered clusters, being somewhat loose but marketable.
Empire State	——	1895	———		5	Somewhat loose but marketable.
Empire State*	——	1897	———		23	Somewhat loose but marketable.
Essex	short	1892	light		1	None but abortive berries set.
Essex	——	1895	light		3	Self-sterile.
Esther	long	1895	———	well filled.	5	Loose but marketable.
Etta	long	1894	———		10	Perfect.
Eumelan	short	1892	good		10	None but abortive berries set.
Eumelan	——	1893	very good		3	Only two berries matured.
Eumelan	——	1895	fair		9	Self-sterile.
Faith	long	1894	very light	loose.	10	Self-sterile.(?)
Fern Munson	long	1896	———		9	Somewhat loose but marketable.
Gærtner	short	1892	fair		1	None but abortive berries set.
Gærtner	——	1895	light	somewhat loose.	5	Self-sterile.
Geneva	long	1894	fair		10	Only a few berries matured.
Geneva	——	1895	fair	somewhat loose.	10	Two clusters matured a few fruits.
Glenfeld	long	1895	———		10	Somewhat loose but marketable.

Gold Dust	long	1895	fair	well formed.	5	Clusters very loose.
Golden Grain	long	1894	——	moderately compact.	5	Somewhat loose but marketable.
Grein Golden	short	1895	fair	somewhat loose.	5	Self-sterile.
Hartford	long	1894	——		5	Somewhat loose but marketable.
Hartford†	——	1897	——		5	Somewhat loose but marketable.
Hayes	long	1894	very light		10	Self-sterile.(?) Vine was very unproductive and apparently not in good condition for the test.
Hayes	——	1895	——	somewhat loose.	10	Self-sterile.(?)
Hayes*	——	1897	——		12	About half the blossoms developed fruit.
Herald	long	1894	——		5	Perfect.
Herbert	short	1892	light	moderately compact.	2	None but abortive berries set.
Herbert	——	1895	fair	somewhat loose.	5	Self-sterile.
Hercules	short	1893	good		4	Self-sterile.
Hercules	——	1895	good	somewhat loose.	10	Self-sterile.
Highland	long	1894	——		10	Somewhat loose but marketable.
Hopican	long	1894	——		5	Somewhat loose but marketable.
Hopkins	——	1896	——		4	Perfect.
Illinois City	long	1895	——		3	Perfect.
Iona	long	1894	——	rather loose.	5	Somewhat loose but marketable.
Iona	——	1898	——	loose.	3	Somewhat loose but marketable.
Isabella	——	1894	——		9	Somewhat loose but marketable.
Isabella†	——	1897	——		11	Less than 50 per cent matured fruit.
Isabella Seedling	long	1895	——	somewhat loose.	10	Somewhat loose but marketable.
Janesville	long	1893	——		2	Perfect.
Janesville	——	1894	——	compact.	10	Perfect.
Jefferson	long	1893	——		3	Somewhat loose but marketable.
Jefferson	——	1894	——		4	Nearly perfect.
Jessica	long	1894	——		10	Less perfect than uncovered clusters.
Jewel	short	1894	fair	not compact.	5	Self-sterile.
Jewel	——	1895	fair		10	Self-sterile.
Juno	long	1895	light		8	Self-sterile.

*Test made at Penn Yan, N. Y. †Test made at Branchport, N. Y. ‡Blossom buds dropped quite a good deal, perhaps due to frost; no fruit on uncovered clusters.

TABLE I.— CHARACTERISTICS OF GRAPE VARIETIES RELATING TO SELF-FERTILITY — *Continued.*

NAME.	Kind of stamens.	Year of test.	Entire yield per vine.	Character of uncovered clusters.	Number of clusters tested.	Remarks on covered clusters.
Lady	long	1894	very light		10	No fruit on covered clusters, uncovered clusters produced only a few ounces of fruit. Vine apparently not in good condition for the test.
Lady	——	1895	——		5	Somewhat loose but marketable.
Lady Washington	long	1894	——	compact.	10	Perfect.
Lady Washington	——	1897	——		19	Nearly perfect.
Leader	long	1895	——		5	Somewhat loose but marketable.
Leavenworth	long	1895	——		5	Perfect.
Lindley	short	1894	light	loose.	10	Self-sterile.
Lindley	——	1895	fair		9	Self-sterile.
Lindley	——	1897	good		25	Self-sterile.
Lindley*	——	1897	——		25	A very few berries developed.
Lindmar	long	1895	——		10	Not quite so perfect as uncovered clusters, being somewhat loose but marketable.
Little Blue	long	1894	——		1	Almost perfect.
Livingston	long	1897	——		10	Somewhat loose but marketable.
Lutie	long	1895	——		5	Perfect.
Mabel	long	1894	——		5	Nearly perfect.
Mabel	——	1897	——		4	Somewhat loose but marketable.
Marie Louise	long	1896	——		5	Clusters loose.
Marie Louise	——	1897	——		5	Somewhat loose but marketable.
Marion	short	1894	good	loose, imperfect, many abortive fruits.	10	Self-sterile.
Marion	——	1897	good		4	Self-sterile.
Marion	——	1898	good	vary from perfect to very loose.	9	Two clusters each ripened one fruit.
Marvin's Seedling	long	1895	——		5	Perfect.

Mary Favorite	long	1894	———	compact.	15	Perfect.
Massasoit	short	1892	fair	compact.	2	None but abortive berries set.
Massasoit	——	1895	light	somewhat loose.	5	Self-sterile.
Mathilde	long	1895	———		5	Perfect.
Maxatawney	long	1893	very light	rather loose.	3	Self-sterile.
Maxatawney	——	1894	very light	rather loose.	10	Self-sterile.
Merrimack	short	1892	fair		2	None but abortive fruit set.
Merrimack	——	1895	fair	rather loose.	10	Self-sterile.
Merrimack*	——	1897	———		23	Self-sterile.
Metternich	long	1894	———		10	Perfect.
Mills	long	1894	———	nearly perfect.	5	Nearly perfect.
Missouri Riesling	long	1895	———	compact or somewhat loose.	10	Somewhat loose but marketable.
Monroe	long	1894	———		5	Perfect.
Montefiore	long	1895	light	somewhat loose.	5	Self-sterile.
Moore Early	long	1894	———		4	Perfect.
Moore Early	——	1895	very light		5	No fruit formed on covered clusters and scarcely any fruit set even on the uncovered clusters. Vine not in good condition for test.
Moore Early	——	1897	———		20	Somewhat loose but marketable.
Moore Early*	——	1897	———		23	Somewhat loose but marketable.
Nectar	long	1894	light		9	Produced only four perfect berries.
Niagara	long	1892	———		10	Perfect.
Niagara*	——	1897	———		23	Somewhat loose yet averaged marketable.
Niagara†	——	1897	———		12	Clusters a little too loose to be called marketable.
Noah	long	1894	light		5	Only a few fruits developed.
Noah	——	1895	good	compact.	5	Too loose to be marketable.
Norfolk†	——	1897	———		2	Somewhat loose but marketable.
N. Muscadine	long	1895	very light	compact.	5	Clusters not marketable.
Norwood	short	1894	very light		10	Self-sterile.
Norwood	——	1895	fair	somewhat loose.	4	One berry matured.
Olita	long	1894	———		10	Somewhat loose but marketable.
Oneida	——	1897	very light		5	Self-sterile.
Opal	long	1894	———		5	Perfect.

* Test made at Penn Yan, N. Y. † Tested at Branchport, N. Y.

TABLE I.— CHARACTERISTICS OF GRAPE VARIETIES RELATING TO SELF-FERTILITY — *Continued.*

NAME.	Kind of stamens.	Year of test.	Entire yield per vine.	Character of uncovered clusters.	Number of clusters tested.	Remarks on covered clusters.
Paradox	long	1895	———		11	Somewhat loose but marketable.
Paragon	long	1894	———		10	Less compact than uncovered clusters; somewhat loose but marketable.
Pearl	long	1896	good		5	Not marketable.
Perkins	long	1894	very light		5	Less compact than uncovered clusters.
Perkins	——	1895	light		10	Less compact than the uncovered clusters; being somewhat loose but marketable.
Pocklington	long	1894	———	compact.	10	Perfect, or nearly so.
Pocklington	——	1895	———		8	Perfect.
Pocklington	——	1895	———		10	Vine not in best condition for test, clusters somewhat loose but marketable.
Pocklington*	——	1897	———		24	Perfect.
Poughkeepsie	long	1894	———	compact.	10	Perfect.
Prentiss	——	1894	———		5	Perfect.
Prentiss*	——	1897	———		6	Somewhat loose but marketable.
Prentiss†	——	1897	———		5	Nearly perfect.
Profitable	long	1894	———		5	Perfect.
Red Bird	short	1894	good	compact.	5	Self-sterile.
Red Bird	——	1895	fair	rather loose.	10	Self-sterile.
Red Eagle	short	1894	fair	very loose.	10	Self-sterile.
Red Eagle	——	1895	very good	well formed.	5	Self-sterile.
Requa	short	1892	fair		2	None but abortive berries set.
Requa	——	1895	good	nearly perfect.	10	Self-sterile.
Rochester	long	1894	———	very compact.	10	Perfect.
Rockwood	long	1895	———		10	Somewhat loose but marketable.

Roenbeck	long	1897	light		5	About two-thirds of blossoms set fruit.
Rogers No. 5	short	1892	fair		2	None but abortive berries set.
Rogers No. 5	——	1895	fair		5	Self-sterile.
Rogers No. 13	long	1892	———		2	Perfect.
Rogers No. 13	——	1898	very good	perfect.	8	Varied from unmarketable to nearly perfect.
Rogers No. 24	——	1892	———		2	Perfect.
Rogers No. 24	——	1898	good	somewhat loose.	6	Varied from unmarketable to perfect.
Rogers No. 32	——	1892	———		2	Perfect.
Rogers No. 32	——	1898	good	somewhat loose.	6	Varied from unmarketable to nearly perfect.
Rommel	long	1894	———	nearly perfect.	5	Nearly perfect.
Rommel	——	1895	———		4	Somewhat loose but marketable.
Roscoe	short	1894	good	moderately compact.	5	Self-sterile.
Roscoe	——	1895	good	well formed.	5	Self-sterile.
Ross (Gov.)	long	1897	very good		8	Clusters rather too loose to be marketable.
Ross (Gov.)	——	1898	good	loose.	3	Nearly perfect.
Rustler	short	1895	fair	rather loose.	5	Self-sterile.
Rutland	long	1894	———	perfect.	5	Perfect.
Rutland	——	1895	———	moderately compact.	5	Somewhat loose but marketable.
Salem	short	1892	very good		10	None but abortive berries set.
Salem*	——	1897	———		23	Self-sterile.
Salem†	——	1897	———		5	Self-sterile.
Senasqua	long	1894	———		5	Perfect.
Shelby	——	1894	———		5	Perfect.
Shull No. 2	long	1897	———		5	Somewhat loose but marketable.
Standard	long	1894	———	compact.	5	Moderately compact.
Telegraph	long	1895	———		4	Perfect.
Thompson No. 7	short	1897	fair		3	Self-sterile.
Thompson No. 5	——	1898	very light	very imperfect.	10	Three seedless fruits were all that developed.
Thompson No. 5	short	1896	light		5	Six berries matured.
Triumph	long	1894	———	nearly perfect.	10	Somewhat loose but marketable.

* Tested at Penn Yan, N. Y. † Tested at Branchport, N. Y.

TABLE I.— CHARACTERISTICS OF GRAPE VARIETIES RELATING TO SELF-FERTILITY — *Concluded.*

NAME.	Kind of stamens.	Year of test.	Entire yield per vine.	Character of uncovered clusters.	Number of clusters tested.	Remarks on covered clusters.
Ulster	long	1894	———	compact.	4	Clusters compact, except two which set no fruit.
Ulster	——	1895	———		10	About like uncovered clusters; somewhat loose but marketable.
Vergennes	long	1894	———	moderately compact.	10	Somewhat loose but marketable.
Vergennes*	——	1897	———		22	Less than half the blossoms set.
Vergennes†	——	1897	———		5	Only one-fourth the blossoms set.
Victoria	long	1895	———		10	Moderately compact.
Victoria	——	1896	———		4	Somewhat loose but marketable.
Vitis aestivalis	long	1892	———	perfect.	5	Perfect.
Vitis aestivalis	——	1894	———	perfect.	10	Perfect.
Vitis arizonica	long	1893	———		5	About 50 per cent of fruit set.
Vitis arizonica	long	1896	———		5	Self-sterile.
Vitis arizonica	——	1898	light	loose.	4	About 1 per cent set fruit.
Vitis berlandieri	short	1894	———	very loose.	5	None but abortive berries set.
Vitis berlandieri	——	1898	———	perfect to very loose.	8	About 4 per cent set fruit.
Vitis berlandieri	——	1895	fair	very loose.	10	Three clusters set a little fruit.
Vitis berlandieri	——	1897	———		5	Self-sterile.
Vitis champini	short	1893	———		5	Self-sterile.
Vitis champini	——	1894	fair	moderately compact.	10	Self-sterile.
Vitis champini	——	1895	fair	loose.	10	Somewhat loose but marketable.
Vitis champini	——	1896	———		4	Loose clusters.
Vitis cinerea	short	1893	———	very loose.	5	None but abortive berries formed.
Vitis cinerea	——	1894	light	very imperfect.	5	None but abortive berries formed.
Vitis cordifolia	short	1897	———		5	Self-sterile. Whole crop bagged.
Vitis doaniana	short	1892	———		2	None but abortive berries set.
Vitis doaniana	——	1894	light	moderately compact.	10	Self-sterile.
Vitis labrusca	long	1892	———		2	Somewhat loose but marketable.

Vitis labrusca	——	1898	————	moderately compact.	7	Somewhat loose but marketable.
Vitis lincecumii, var. *glauca*	——	1898	————		10	Perfect.
Vitis rupestris	short	1893	————		5	One berry developed.
Vitis rupestris	——	1898	good	somewhat loose.	6	Self-sterile.
Vitis rupestris	——	1897	————		5	Self-sterile.
Vitis solonis	short	1893	————		5	Two berries developed.
Vitis solonis	——	1894	————		10	Self-sterile.
Vitis solonis, var. *novo mexicana*	short	1893	————	moderately compact.	5	Self-sterile.
Vitis solonis, var. *novo mexicana*	——	1894	————		5	Only a few berries developed.
Vitis vulpina	short	1898	————	somewhat loose.	8	Somewhat loose, about like uncovered clusters.
Wheaton	long	1895	————		5	Somewhat loose but marketable.
White Jewel	long	1895	fair		10	Self-sterile.
Wilder	short	1892	fair		2	Only abortive berries set.
Wilder	——	1895	light		5	Self-sterile.
Winchell	long	1892	————		10	Perfect.
Witt	long	1897	————		5	Somewhat loose but marketable.
Woodruff	long	1894	very light		5	Self-sterile.
Woodruff	——	1895	light		5	Only a few berries developed.
Worden	long	1894	————		10	Somewhat loose but marketable.
Worden	——	1895	————	perfect.	9	Perfect.
Worden	——	1897			23	Perfect.
Worden*	——	1897	————		20	Nearly perfect.
Worden†	——	1897	————		5	Somewhat loose but marketable.
Wyoming	short	1896	good		10	Self-sterile.

* Tested at Penn Yan, N. Y. † Tested at Branchport, N. Y.

IS THE METHOD OF TESTING FOR SELF-FERTILITY BY COVERING THE CLUSTERS A RELIABLE ONE?

The reliability of the method of testing the self-fertility of a variety by covering its blossoms during the blooming period and thus excluding pollen from other flowers, has been questioned by some on the ground that the conditions within the covering may be very different from those outside and especially that the exclusion of winds and insects prevents pollination.[1] These objections will be considered here only so far as they concern the work with grapes.

Perhaps the best reply which can now be offered to these objections is the statement that out of 169 cultivated varieties of the grape which have been tested here by this method 103 produce on the average marketable clusters when the blossoms are covered. As one illustration out of many that might be given on this point, the record of Diamond is presented. In 1892, 2 clusters of this variety in one of the Station vineyards were bagged during the entire blossoming period. Two perfect clusters of fruit developed. In 1897, 15 clusters of the same variety were likewise covered in a vineyard near Penn Yan and 18 clusters in a vineyard near Branchport. Each covered cluster developed into a perfect cluster of fruit. Plate LII from a photograph of self-sterilized clusters of Duchess and Diamond, covered during the blooming period according to the method under discussion, shows how perfectly the covered clusters of self-fertile varieties may develop. Even with those varieties which show some variableness in the degree of self-fertility under differences of environment, the results with the same variety have generally been quite similar in the different tests.

Attention should be called to the fact that every one of the 103 self-fertile varieties cited above has flowers with long stamens. If these varieties were able to become successfully self-pollinated

[1] Proc. Amer. Pom. Soc., 1897: 94. See also Fletcher, S. W. Reprint from Proc. N. J. State Hort. Soc., 1899: 12–14.

when the blossoms were covered, there can be no doubt that self-pollination occurs with all long-stamened varieties. Even with short-stamened varieties it cannot be maintained that self-pollination is altogether prevented by covering the blossoms by the method under consideration; for in these experiments some covered clusters of short-stamened varieties have fruited sparingly. Further discussion of pollination of the grape is reserved for a future report.

ENVIRONMENT MAY MODIFY SELF-FERTILITY.

The influence of environment on the self-fertility of the grape has not received the attention which it deserves. In order to secure some data on this subject varieties which had previously been tested at the Station were tested again in other localities, 20 of them in the vineyard of Mr. E. C. Gillett, Penn Yan, N. Y., and 15 in the vineyards of Mr. George C. Snow, near Branchport, N. Y. Much credit is due these gentlemen for courtesies extended to the Station and for their cordial cooperation in the work.

Four of the varieties were tested in both these places and at the Station so that tests with them were made in 3 localities the same season. Eleven varieties were tested in 2 different localities simultaneously. The results of the tests in the different localities are presented briefly in the following tabulation:

TABLE II.—RECORDS FOR SAME VARIETY OF GRAPES IN DIFFERENT LOCALITIES.

NAME.	Location.	Year of test.	Number clusters tested.	Remarks.
Brighton	Station	1892	9	None but abortive berries formed.
Brighton	Station	1895	5	Self-sterile.
Brighton	Station	1897	27	Self-sterile.
Brighton	Penn Yan	1897	25	Only one cluster produced fruit and that had but one berry.
Brighton	Branchport	1897	5	Three of the clusters formed a few berries. The character of these clusters is shown in Fig. 1, Plate LI.
Catawba	Station	1894	12	Clusters averaged somewhat loose but were marketable.
Catawba	Penn Yan	1897	16	Clusters much the same as in 1894 test.
Catawba	Branchport	1897	22	Clusters slightly more compact than at Penn Yan.
Clinton	Station	1894	10	Clusters averaged somewhat loose but marketable.
Clinton	Branchport	1897	4	Clusters too loose to be called marketable.
Concord	Station	1892	10	Clusters averaged somewhat loose but marketable.
Concord	Penn Yan	1897	20	Clusters much the same as in 1892 test.
Concord	Branchport	1897	11	Clusters much the same as in 1892 test.
Creveling	Station	1894	5	Self-sterile.
Creveling	Station	1895	5	Self-sterile.
Creveling	Branchport	1897	5	Self-sterile.
Delaware	Station	1892	10	Clusters perfect.
Delaware	Penn Yan	1897	21	Clusters averaged somewhat loose but marketable.
Delaware	Branchport	1897	18	Clusters slightly better than at Penn Yan.
Diamond	Station	1892	2	Clusters perfect.
Diamond	Penn Yan	1897	15	Clusters perfect.
Diamond	Branchport	1897	18	Clusters perfect.
Diana	Station	1894	4	Clusters averaged somewhat loose but marketable.
Diana	Station	1895	5	Clusters perfect or nearly so.
Diana	Penn Yan	1897	10	Clusters perfect.
Diana	Branchport	1897	5	Clusters but little more than half filled.

Duchess	Station	1894	10	But 15 per cent to 20 per cent of the blossoms set fruit. Vine probably not in good condition for test.
Duchess	Penn Yan	1897	21	Clusters averaged nearly perfect.
Duchess	Station	1898	14	Clusters perfect.
Eldorado	Station	1894	5	Self-sterile.
Eldorado	Station	1895	5	Self-sterile.*
Eldorado	Penn Yan	1897	23	Self-sterile.
Empire State	Station	1894	10	Clusters averaged somewhat loose but marketable.
Empire State	Station	1895	5	Clusters much the same as in 1894.
Empire State	Penn Yan	1897	23	Clusters much the same as in 1894.
Hartford	Station	1894	5	Clusters averaged somewhat loose but marketable.
Hartford	Branchport	1897	5	Clusters much the same as in 1894.
Hayes	Station	1894	10	Self-sterile (?) } Vine not in good condition for the test.
Hayes	Station	1895	10	Self-sterile (?) }
Hayes	Penn Yan	1897	12	About half of the flowers developed into fruit.
Isabella	Station	1894	9	Clusters averaged somewhat loose but marketable.
Isabella	Branchport	1897	11	Hardly half of the blossoms set fruit.
Lady Washington	Station	1894	10	Clusters perfect.
Lady Washington	Penn Yan	1897	19	Clusters almost perfect.
Lindley	Station	1894	10	Self-sterile.
Lindley	Station	1895	9	Self-sterile.
Lindley	Penn Yan	1897	25	But one cluster developed fruit. It had four berries.
Lindley	Station	1897	25	Self-sterile.
Merrimack	Station	1892	2	Self-sterile. Some abortive fruit formed but none perfect.
Merrimack	Station	1895	10	Self-sterile.
Merrimack	Penn Yan	1897	23	Self-sterile.
Moore Early	Station	1894	4	Clusters perfect.
Moore Early	Station	1895	5	Clusters self-sterile. (?) Vine not in good condition for the test.
Moore Early	Penn Yan	1897	23	Clusters averaged somewhat loose but marketable.
Moore Early	Station	1897	20	Clusters averaged slightly better than at Penn Yan.
Niagara	Station	1892	10	Clusters perfect.

*Probably injured by frost; for the blossom buds dropped and no fruit developed on uncovered clusters.

TABLE II.— RECORDS FOR SAME VARIETY OF GRAPES IN DIFFERENT LOCALITIES.— *Concluded.*

NAME.	Location.	Year of test.	Number clusters tested.	Remarks.
Niagara	Penn Yan	1897	23	Clusters loose yet averaged marketable.
Niagara	Branchport	1897	12	Clusters a little too loose to be classed as marketable.
Pocklington	Station	1894	10	Clusters perfect or nearly so.
Pocklington	Station	1895	8	Clusters perfect.
Pocklington	Station	1895	10	Vine not in best condition for the test. Clusters somewhat loose but marketable.
Pocklington	Penn Yan	1897	24	Clusters perfect.
Prentiss	Station	1894	5	Clusters perfect.
Prentiss	Penn Yan	1897	6	Clusters averaged somewhat loose but marketable.
Prentiss	Branchport	1897	5	Clusters averaged nearly perfect.
Salem	Station	1892	10	Some abortive fruit, but none perfect.
Salem	Penn Yan	1897	23	Self-sterile.
Salem	Branchport	1897	5	Self-sterile.
Vergennes	Station	1894	10	Clusters nearly as compact as the uncovered clusters, being somewhat loose but marketable.
Vergennes	Penn Yan	1897	22	Clusters on the average not half filled.
Vergennes	Branchport	1897	5	Clusters even more imperfect than at Penn Yan.
Worden	Station	1894	10	Clusters averaged somewhat loose but marketable.
Worden	Station	1895	9	Clusters perfect.
Worden	Station	1897	23	Clusters perfect.
Worden	Penn Yan	1897	20	Clusters almost perfect.
Worden	Branchport	1897	5	Clusters somewhat loose but marketable.

DISCUSSION OF RESULTS.

The records of the same variety for the same season in different localities will first be considered to see what influence a difference in locality appeared to have on the degree of self-fertility.

At Penn Yan the self-fertilized Niagara clusters were nearly compact enough, on the average, to be called marketable; at Branchport they were slightly looser. At Penn Yan, Vergennes covered clusters averaged nearly half-filled, but at Branchport the covered clusters on the average were about one-fourth filled. At Penn Yan and at the Station, Worden self-fertilized gave nearly perfect clusters, but at Branchport only moderately compact clusters. At Penn Yan self-fertilized Diana gave perfect clusters, but at Branchport its clusters averaged but little more than half filled. At Penn Yan self-fertilized Prentiss on the other hand bore only moderately compact clusters, while at Branchport it bore nearly perfect clusters. At Penn Yan, Lindley, out of 25 covered clusters, produced fruit on but one and that bore four berries; 25 clusters covered at the Station gave no fruit. At Penn Yan 25 covered clusters of Brighton produced but one fruit; at Branchport 5 clusters were covered and 3 produced fruit (see Plate LI, Figure 1); at the Station 27 were covered but no fruit formed.

It appears from these records that some varieties show a difference in the degree of self-fertility which they possess in different locations. On the other hand other varieties which were tested in the same season in the different locations gave practically similar results in different localities. Brighton, Catawba, Concord, Delaware, Diamond and Salem gave practically similar results for the same variety at Penn Yan and at Branchport. Moore, Early and Worden gave similar results for the same variety at Penn Yan and at the Station.

Some of the varieties tested at Penn Yan and Branchport were not tested at the Station the same season, but were tested there in various other seasons. In these cases the differences in environ-

ment are greater than in the cases which have just been considered, for not only were the tests made in different locations but in different seasons. Catawba, Concord, Creveling, Diamond, Duchess, Eldorado, Empire State, Hartford, Lady Washington, Merrimack, Pocklington, Salem and Worden gave quite similar results for each variety in the different tests, thus furnishing additional evidence that there are varieties which show little if any variability in the degree of self-fertility under decidedly different environment.

Clinton, Delaware, Diana, Isabella, Moore Early, Niagara, Prentiss and Vergennes gave more or less variable results with the same variety in the different tests and different seasons.

Taking into consideration all varieties which have been tested at the Station more than one season, it is seen that in a majority of cases the same variety shows a like degree of self-fertility in different seasons. In several instances the degree of self-fertility varies somewhat with the same variety in different seasons, but very rarely is the variation decidedly marked.

But little has been done in comparing the degree of self-fertility of vines of the same variety located in different parts of the same vineyard. Such comparisons are not necessary to show that the degree of self-sterility may in some varieties be modified by differences in location. It has just been shown that with certain grapes the degree of self-fertility varies under differences of environment. In some instances it is known to vary with the same variety in different vineyards, with the same vine in different seasons, with different clusters on the same vine and even with different blossoms in the same cluster. With such variable varieties it will without doubt vary the same season in different parts of the same vineyard, for so far as soil conditions are concerned different parts of the same vineyard may vary sufficiently to cause marked differences in the growth and physiological conditions of the vines.

MAY VARIETIES BE CLASSIFIED ON THE BASIS OF SELF-FERTILITY?

In previous reports of this work classified lists of self-fertile, imperfectly self-fertile and self-sterile grapes have been made for the guidance of grape growers. The question now arises whether the variation in the degree of self-fertility of some varieties is sufficiently great to make such a classification of them unreliable. An examination of the changes in the classification which have been brought about by extending the experiments to more than one location and into more than one season will throw some light on this question. All of these discussions refer to normally productive vines unless otherwise stated. Care must be taken to distinguish between variations in yield due to an unproductive condition of a portion or all of the vine and that which is due to self-sterile blossoms.

Looking at the self-sterile lists it is found that Brighton, Eumelan, Lindley, Marion, Norwood and Woodruff have at one time been classified as self-sterile.[1] In later tests they have produced from one to several fruits.

Similar changes have been made in the lists of perfectly self-fertile sorts. The following varieties have produced none but perfect clusters from self-fertilized blossoms in some tests while in others a portion or even all of the clusters have been somewhat loose. Antoinette, Berckmans, Bertha, Cottage, Delaware, Diana, Early Golden, Mabel, Moore Early, Niagara, Pocklington Prentiss, Rutland, Worden.

The following varieties, so far as tested, have produced none but perfect clusters when the blossoms were covered: Ambrosia, Columbia, Croton, Diamond, Etta, Herald, Hopkins, Janesville, Lady Washington, Leavenworth, Lutie, Marvin Seedling White,

[1] It is doubtful whether the Hayes and Denison vines were in good condition at the time the first tests were made in which they were self-sterile. In later tests they produced clusters about half filled from self-fertilized blossoms. With these exceptions the vines in the self-sterile lists have shown unvarying self-sterility so far as tested.

Mary Favorite, Mathilde, Metternich, Monroe, Opal, Poughkeepsie, Profitable, Rochester, Senasqua, Shelby, Telegraph, Winchell.

In the lists of grapes which give somewhat loose though marketable clusters, when self-fertilized, and of those which give clusters too loose to be called marketable, certain varieties have given somewhat variable results in different tests, in some instances showing as great variation as in any of the cases cited above.

It has been shown on preceding pages that in certain varieties the degree of self-fertility is not unchangeable. Its limits, therefore, may not be defined with mathematical exactness, yet with rare exceptions its variableness in any variety is confined within rather narrow limits. Not all varieties have shown marked differences in the results of different tests. In fact in the majority of cases the results have been practically similar with the same variety in different seasons and different locations, so far as tested. A classification based on such tests as have been reported above will show with considerable accuracy the normal degree of self-fertility of a variety, although the limits of the classes will necessarily be somewhat variable. Such a classification is given below. It is probable that slight changes may be made in it after further testing of these varieties. Other varieties may need to be transferred from the lists of self-sterile to the list of imperfectly self-fertile sorts as has already been done with Brighton, Lindley, Eumelan, Marion, Norwood and Woodruff. For all cultural purposes, however, such grapes may still be considered as belonging to the category of self-fertile sorts. Changes from one class to a widely different class, as from the self-sterile class to either of the classes of grapes capable of producing marketable self-fertilized clusters, are not to be expected. In other words, it is believed that the classification as given below is on the whole sufficiently reliable to serve the purposes of grape growers who are seeking information as to which varieties are able to produce good clusters of fruit when planted alone and with which ones cross-pollination is necessary to the production of good clusters.

In the following classification the varieties are arranged in four classes according to the average character of the clusters which have developed from covered blossoms on vines in apparently normal condition. In cases where there is doubt as to whether the vine was in proper condition for the test the name is followed by a question mark to indicate that the classification is doubtful.

Class 1 includes varieties which when self-fertilized have formed none but perfect clusters and those with which the clusters have varied from perfect to somewhat loose.

Class 2 includes varieties which when self-fertilized have on the average formed marketable, although not compact clusters.

Class 3 includes varieties which when self-fertilized have on the average produced clusters too loose to be marketable. This class has a wide range. It extends from the varieties in Class 2 with clusters not too loose to be marketable, to Class 4 which includes the self-sterile sorts. There are varieties in this class which have on the average produced self-fertilized clusters nearly compact enough to be marketable, some being rather compact, but others being loose. At the lower limits of the class are found varieties which usually fail to produce fruit on covered clusters but which occasionally have borne a few scattering fruits when the clusters were covered.

Class 4 includes those varieties which have not produced any fruit on covered clusters.

CLASSIFICATION ACCORDING TO SELF-FERTILITY.

Class 1. Clusters Perfect or Varying from Perfect to Somewhat Loose.

Ambrosia
Antoinette
Berckmans
Bertha
Columbia
Cottage
Croton
Delaware
Diamond
Diana
Early Golden
Etta
Herald
Hopkins
Janesville
Lady Washington
Leavenworth
Lutie
Mabel
Marvin Seedling White
Mary Favorite
Mathilde
Metternich
Monroe
Moore Early
Niagara
Opal
Poughkeepsie
Pockington
Profitable
Prentiss
Rochester
Rutland
Senasqua
Shelby
Telegraph
Winchell
Worden

Class 2. Clusters Marketable; Moderately Compact or Loose.

Agawam	Early Ohio	Little Blue
Alice	Early Victor	Livingston
Arkansaw	*Edmeston No.* 1	Marie Louise
Bailey	Elsinburg	Mills
Big B. Con.	Elvira	Missouri Riesling
Big Extra	Empire State	Norfolk
Brilliant	Esther	Olita
Brown	Fern Munson	Paradox
Burrows No. 42c	Glenfeld	Paragon
Carman	Golden Grain	Perkins
Catawba	Hartford	Rockwood
Caywood No. 50	Highland	*Rogers No.* 13
Centennial	Hopican	*Rogers No.* 24
Champion (Cortland)	Illinois City	*Rogers No.* 32
Chandler	Iona	Rommel
Chautauqua	Isabella	*Shull No.* 2
Clinton	Isabella Seedling	Standard
Colerain	Jefferson	Triumph
Concord	Jessica	Ulster
Dr. Collier	Lady	Victoria
Duchess	Leader	Wheaton
Early Market	Lindmar	Witt

Class 3. Clusters Unmarketable.[1]

Adirondack	Dracut Amber	Northern Muscadine (?)
Alexander Winter	Eumelan	Norwood
Amber Queen	Geneva	Pearl
Beagle	Gold Dust	Roenbeck
Big Hope	Hayes	[2]Ross (Gov.)
Brighton	Lindley	*Thompson No.* 5
Canada	Marion	*Thompson No.* 7
Canonicus	Nectar	Vergennes
Daisy	Noah	Woodruff
Denison		

Class 4. Self-Sterile. No Fruit Develops on Covered Clusters.[1]

Aledo	Elvibach	Montefiore
Amber (?)	Essex	Oneida
America	Faith (?)	Red Bird
Aminia	Gærtner	Red Eagle
Barry	Grein Golden	Requa
Black Eagle	Herbert	*Rogers No.* 5
Blanco	Hercules	Roscoe
Burnet	Jewel	Rustler
Clevener	Juno	Salem
Creveling	Massasoit	White Jewel
Dr. Hexamer	Maxatawney (?)	Wilder
Eaton (?)	Merrimack	Wyoming
Eldorado		

VARIETIES SHOULD NOT BE PLANTED ALONE.

These investigations have a practical bearing both on the selection of varieties and on their arrangement when planted. The self-sterile kinds cannot be expected to set fruit when they stand

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[1] In cases where the vines were not in good condition throughout the test the classification is marked as questionable.

[2] Further testing may show that Gov. Ross belongs in Class 2.

alone. Plate L shows what was left of covered Eumelan clusters at the time the fruit ripened on the uncovered clusters. It is seen that not a fruit developed when the Eumelan was compelled to depend on itself for setting fruit. Herbert and Barry likewise fail to fruit when dependent on their own blossoms for pollination. Brighton does but little better. The best results which its covered clusters gave in these investigations are the three clusters shown in Plate LI, Figure 1. But self-sterile varieties may produce well formed clusters when located near enough to other kinds of grapes so that cross-pollination can occur. The clusters of Herbert and Barry shown in Plate LIII, and that of Brighton shown in Plate LI, Figure 2, were borne on vines which were located favorably for cross-pollination.

The varieties which are named in Classes 1 and 2 produce well formed clusters of themselves. The covered clusters of Duchess and Diamond illustrated in Plate LII show what perfect clusters may develop on varieties in these classes when the blossoms are self-pollinated. The varieties named in Classes 1 and 2 may therefore be planted alone without reference to cross-pollination.

DATES OF BLOOMING.

The following table is given in order to assist in determining what varieties may be used for cross-pollinating the varieties which are named in Classes 3 and 4. It shows the dates of blooming for vines in the Station vineyards only. Where but one date is given it shows when the first blossoms opened. The second of two dates shows the close of the blooming period.[1]

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[1] The grape usually continues in bloom from six to ten days after the first blossom opens. The time from the opening of the first blossom till the vine comes into full bloom, that is to say, till a large proportion of the clusters are blooming, varies according to temperature conditions. If the weather be warm, it may not take more than from twenty-four to forty-eight hours. If the weather be cool, it will take a correspondingly longer time. The conditions of temperature, therefore, determine largely the length of the period of bloom. Millardet has shown that it is the temperature and not the degree of light which influences the rapidity of anthesis of the grape. Anthesis

It is important to note that the vulpina species (riparia Mx.) is the first to come into blossom, see Clinton and the hybrids, Canada, Clevener, etc.; the æstivalis species comes next, see its hybrids, Ulster, Mills, etc.; afterwards the labrusca species comes into bloom, see Concord, Isabella, etc.

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begins when the temperature rises to 15 deg. to 17 deg. C. (59 deg. to 62.6 deg. Fahr.), and at 25 deg. C. (77 deg. Fahr.), it progresses very rapidly. As the temperature falls again, anthesis is retarded till at 15 deg. C. it ceases. See Essai sur L' Hybridation de la Vigne, 15, 16. Paris: 1891.

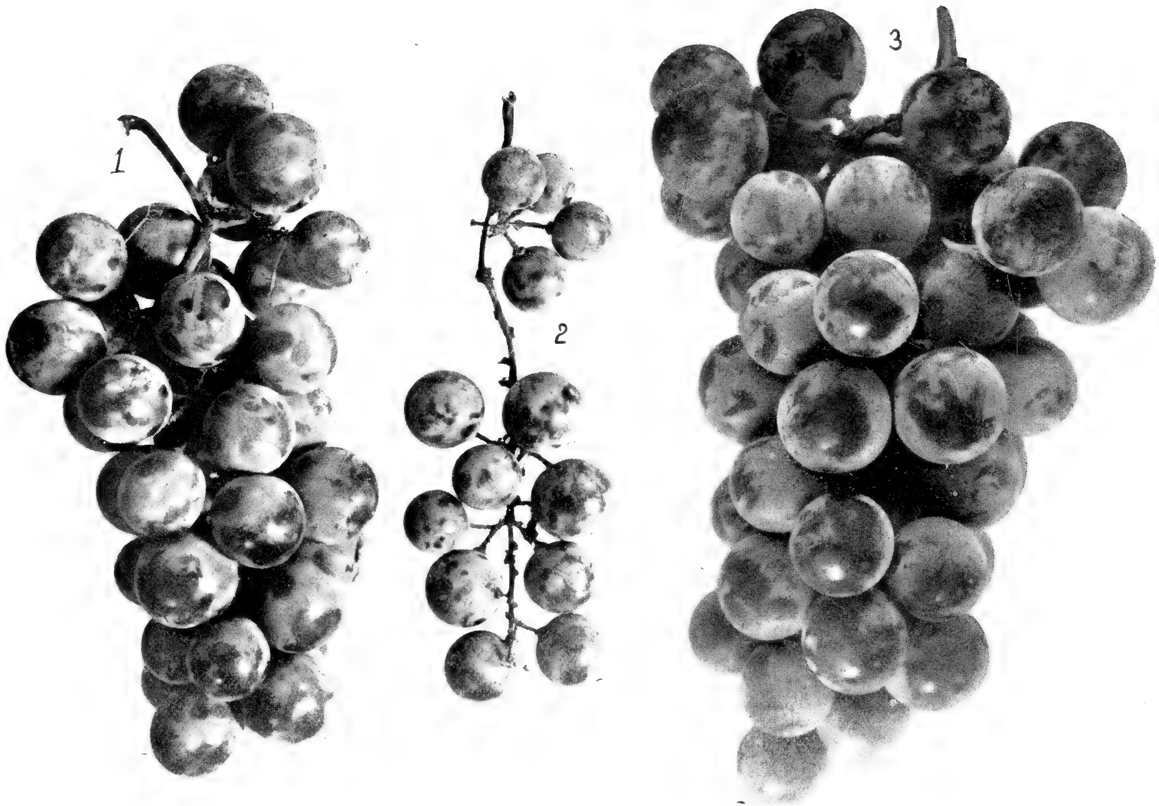

Plate XLIX.

Plate L.

PLATE LI.

Plate LII.

Plate LIII.

EXPLANATION OF PLATES.

Plate XLIX.— *Fig.* 1. *Vergennes self-fertilized; perfect cluster.*

Fig. 2. *Vergennes self-fertilized; imperfect cluster.*

Fig. 3. *Vergennes open to cross-pollination.*

Plate L.— *Eumelan self-fertilized.*

Plate LI.— *Fig.* 1. *Brighton self-fertilized.*

Fig. 2. *Brighton open to cross-pollination.*

Reduced one-third.

Pdate LII.— *Fig.* 1. *Diamond self-fertilized.*

Fig. 2. *Duchess self-fertilized.*

Reduced nearly one-third.

Plate LIII.— *Fig.* 1. *Herbert.*

Fig. 2. *Barry.*

Reduced nearly one-half.

DATES OF BLOOMING OF GRAPES.

VINEYARD 7.

	1892.	1893.	1894.	1895.	1896.	1897.
Agawam	June 21	June 19	June 20	June 6	——	June 28 to July 3
Amber Queen	June 18	June 17	June 18	June 4	June 6	June 21 to July 1
Barry	June 20	June 17	June 19	June 6	June 6	June 23 to July 1
Brighton	June 22	June 19	June 19	June 7	June 4	June 24 to July 3
Burnet	June 22	June 19	June 20	June 5	June 6	June 24 to July 3
Catawba	June 21	June 17	June 19	June 6	June 8	June 24 to July 2
Centennial	June 22	June 19	June 20	June 11	June 6	June 24 to July 3
Champion	——	——	June 14	June 2	——	June 19 to July 1
Concord	June 21	June 19	June 16	June 4	June 6	June 24 to July 4
Duchess	June 23	June 20	June 20	June 6	June 6	June 28 to July 5
Eaton	June 22	June 17	June 18	June 6	——	June 25 to July 3
Empire State	June 22	June 19	June 19	June 7	——	July 1 to July 5
Eumelan	June 20	June 19	June 18	June 6	——	June 24 to July 5
Hartford	June 20	June 17	June 18	June 4	——	June 20 to July 1
Hayes	June 21	June 20	June 19	June 6	June 6	June 23 to July 5
Highland	June 21	June 20	June 20	June 7	——	——
Iona	June 23	June 19	June 21	June 10	——	June 28 to July 3
Isabella	June 21	June 17	June 18	June 4	——	June 23 to July 2
Jefferson	June 23	June 19	June 22	June 9	June 12	June 26 to July 4
Jessica	June 18	June 17	June 16	June 3	June 5	June 23 to July 1
Lady	June 18	June 17	June 20	June 9	——	——
Lady Washington	June 22	June 19	June 20	June 7	——	June 24 to July 1
Lindley	June 21	June 19	June 18	June 6	——	June 24 to July 3
Monroe	June 21	June 17	June 18	June 11	June 6	June 23 to July 1
Moore Early	June 21	June 19	June 18	June 4	June 6	June 24 to July 1
Niagara	June 20	June 17	June 18	June 6	——	June 24 to July 3
Norwood	June 22	June 19	June 19	June 6	June 7	June 28 to July 3
Pocklington	June 20	June 19	June 18	June 5	June 5	June 24 to July 3
Prentiss	June 22	June 22	June —	June 9	——	——
Rochester	June 20	June 17	June 16	June 6	June 6	June 24 to July 1

Salem	June 21	June 17	June 16	June 4	June 6	June 22 to June 30
Ulster	June 18	June 15	June 14	June 3	———	June 18 to June 30
Vergennes	June 21	June 19	June 18	June 6	June 6	June 24 to July 1
Wilder	June 17	June 17	June 17	June 6	June 5	June 24 to July 1
Winchell	June 21	June 17	June 19	June 6	June 8	June 24 to July 1
Woodruff	June 18	June 17	June 16	June 4	———	June 21 to June 30
Worden	June 20	June 17	June 16	June 5	June 5	June 20 to July 2

VINEYARD 8.

	1892.	1893.	1894.	1895.	1896.	1897.	1898.
Adirondack	June 22	June 20	June 18	June 6	———	June 28 to July 2	June 15 to June 20
Agawam	———	———	———	———	June 6	June 23 to June 30	June 16 to June 20
Aledo	———	June 20	June 20	June 7	June 6	June 28 to July 3	June 16 to June 25
Alexander Winter	———	———	———	June 4	June 8	June 23 to June 30	June 15 to June 20
Alice	June 21	June 19	June 18	June 4	———	June 24 to July 4	June 15 to June 25
Amber	June 20	June 17	June 17	June 3	June 3	June 24 to July 2	June 15 to June 20
Ambrosia	June 20	June 17	June 17	June 3	June 2	June 24 to July 2	June 15 to June 20
America	———	———	———	June 10	June 6	June 30 to July 3	June 23 to June 30
Aminia	June 21	June 19	June 19	June 5	June 4	June 24 to June 30	June 15 to June 21
Antoinette	———	———	———	———	June 4	June 24 to June 30	June 15 to June 24
Arkansaw	———	———	———	June 6	June 4	June 24 to June 30	June 13 to June 19
Bailey	———	———	———	June 12	———	July 3 to July 7	June 25 to July 1
Barry	———	———	June 21	June 4	June 6	June 24 to June 30	June 16 to June 20
Beagle	June 18	June 18	June 15	June 3	June 2	June 21 to July 1	June 13 to June 20
Berckmans	———	———	———	June 6	May 26	June 19 to June 25	June 11 to June 17
Bertha	———	———	———	June 6	June 5	June 26 to July 2	June 16 to June 25
Big B. Con.	———	———	———	June 13	June 8	July 13	June 23 to July 1
Big Extra	———	———	———	June 16	June 12	July 2	June 24 to July 1
Big Hope	———	———	———	June 13	June 7	July 3 to July 10	June 21 to June 29
Black Eagle	———	———	———	June 10	———	June 28 to July 5	June 20 to June 27
Black Eagle	June 22	June 19	June 20	June 10	———	June 28 to July 3	June 20 to June 29
Brighton	June 22	June 19	June 19	June 6	———	June 28 to July 4	June 20 to June 26
Brilliant	———	———	———	June 6	June 6	June 26 to July 1	June 16 to June 26

DATES OF BLOOMING OF GRAPES — *Continued.*

VINEYARD 8 — *Continued.*

	1892.	1893.	1894.	1895.	1896.	1897.	1898.
Brilliant	June 22	June 19	June 19	June 6	———	June 28 to July 1	June 20 to June 27
Brown	———	———	———	June 6	June 1	June 20 to June 30	June 13 to June 21
Canada	June 18	June 17	June 18	June 3	June 3	June 22 to June 30	June 13 to June 20
Canonicus	June 21	June 19	June 20	June 10	June 6	June 30 to July 4	June 20 to June 26
Carman	———	———	———	June 13	June 12	July 2 to July ?	June 25 to July 2
Caywood No. 50	June 20	June 17	June 18	June 5	May 29	June 20 to June 30	June 15 to June 20
Champion	———	———	———	June 2	June 4	June 21 to June 30	June 11 to June 17
Chandler	———	———	———	June 5	June 5	June 24 to July 2	June 16 to June 24
Chautauqua	———	———	———	June 6	June 4	June 24 to July 1	June 15 to June 20
Clevener	June 15	June 10	June 12	June 1	May 22	June 15 to June 24	June 9 to June 15
Clinton	June 15	June 10	June 12	June 1	May 23	June 15 to June 24	June 8 to June 15
Colerain	———	———	———	June 4	June 5	June 24 to July 2	June 16 to June 24
Columbia	———	———	———	———	———	June 24 to June 30	June 20 to June 27
Cottage	June 20	June 17	June 16	June 1	June 2	June 23 to June 30	June 15 to June 20
Creveling	June 23	June 19	June 18	June 6	———	June 26 to July 3	June 16 to June 23
Croton	June 20	June 20	June 22	June 11	———	June 4	June 23 to July 1
Daisy	June 21	June 19	June 20	June 7	———	———	June 16 to June 21
Delaware	———	June 19	June 18	June 6	June 6	June 26 to July 5	June 20 to June 29
Diamond	June 22	June 19	June 20	June 7	———	June 30	June 20 to June 28
Diana	June 20	June 19	June 19	June 4	June 5	June 23 to June 30	June 15 to June 21
Dr. Collier	———	———	———	June 12	June 8	July 2	June 23 to June 30
Dr. Hexamer	———	———	———	June 10	June 6	July 1 to July 6	June 23 to July 1
Dracut Amber	June 20	June 17	June 18	June 5	June 4	June 24 to June 30	June 15 to June 20
Early Golden	———	———	———	June 11	———	June 30 to July 5	June 20 to June 30
Early Market	June 18	June 17	June 17	June 4	June 4	June 23 to June 30	June 13 to June 21
Early Ohio	———	June 19	June 17	June 4	June 6	June 23 to June 30	June 15 to June 23
Early Victor	———	———	———	June 4	June 4	June 23 to July 1	June 15 to June 24
Edmeston No. 1	———	———	———	June 7	June 6	June 26 to July 2	June 16 to June 26
Eldorado	June 21	June 20	June 20	June 10	———	June 30 to July 4	June 16 to June 21
Elsinburg	June 27	June 22	———	June 12	———	July 2 to July 4	June 25 to July 1

Elvibach	June 18	June 19	June 18	June 4	June 5	June 20 to June 26	June 13 to June 20
Elvira	June 17	June 15	June 16	June 3	June 2	June 20 to June 28	June 12 to June 19
Essex	June 21	June 17	June 19	June 6	June 4	June 24 to June 30	June 15 to June 30
Esther	——	——	——	June 6	June 4	June 23 to July 2	June 16 to June 24
Etta	June 17	June 15	June 17	June 4	June 4	June 21 to June 30	June 13 to June 21
Faith	June 17	June 15	June 15	June 3	June 1	June 18 to June 30	June 11 to June 17
Fern Munson	——	——	——	June 12	June 13	July 2 to July 4	June 24 to June 30
Gærtner	June 20	June 19	June 19	June 6	June 8	June 28 to July 4	June 16 to June 25
Geneva	June 21	June 19	June 20	June 8	——	June 30 to July 4	June 16 to June 21
Glenfeld	June 20	June 17	June 18	June 4	June 5	June 24 to July 2	June 15 to June 21
Gold Dust	June 22	June 17	June 18	June 6	June 7	June 30 to July 6	June 15 to June 27
Golden Grain	June 22	June 17	June 21	June 3	June 4	June 28 to July 6	June 15 to June 23
Grein Golden	——	——	——	June 9	June 3	June 23 to June 30	June 13 to June 21
Hartford	June 18	June 17	June 18	June 3	June 5	June 24 to June 30	June 13 to June 20
Herald	June 18	June 17	June 18	June 6	June 3	June 23 to July 2	June 15 to June 26
Herbert	June 20	June 17	June 18	June 4	June 4	June 24 to June 30	June 13 to June 20
Hercules	June 21	June 19	June 18	June 4	June 6	June 24 to June 30	June 16 to June 21
Hopican	June 21	June 19	June 19	June 6	June 6	June 30 to July 2	June 16 to June 28
Hopkins	——	——	——	——	——	July 3	June 27 to July 3
Illinois City	——	——	——	June 7	June 4	June 26 to July 4	June 16 to June 27
Iona	——	June 19	June 20	June 6	——	——	June 20 to June 28
Isabella Seedling	June 20	June 17	June 18	June 4	June 4	June 24 to July 3	June 15 to June 20
Janesville	June 15	June 12	June 11	May 30	May 23	June 14 to June 24	June 11 to June 15
Jewell	June 19	June 17	June 18	June 3	——	June 24 to July 2	June 16 to June 25
Juno	June 20	June 17	June 18	June 6	June 6	June 28 to July 5	June 16 to June 26
Leader	——	——	——	——	June 5	June 26 to July 4	June 16 to June 25
Leavenworth	——	June 19	June 18	June 6	June 4	June 24 to July 4	June 16 to June 21
Lindmar	June 18	June 17	June 18	June 3	——	June 26 to July 2	June 15 to June 22
Little Blue	June 22	June 17	June 18	June 3	June 2	June 23 to July 2	June 15 to June 21
Livingston	——	——	——	June 9	——	June 26 to July 4	June 16 to June 25
Lutie	——	——	——	June 4	May 29	June 21 to June 30	June 15 to June 21
Mabel	June 21	June 19	June 18	June 3	June 8	June 24 to July 4	June 13 to June 21
Marie Louise	——	——	——	June 12	June 4	June 26 to July 3	June 16 to June 27
Marion	June 15	June 12	June 11	June 1	May 22	June 16 to June 21	June 8 to June 15
Marvin Seedling	——	——	——	June 6	June 5	June 26 to July 4	June 16 to June 25
Mary Favorite	June 15	June 14	June 15	June 2	May 26	June 16 to June 26	June 11 to June 17
Massasoit	June 20	June 19	June 19	June 6	——	June 30 to July 3	June 16 to June 27

DATES OF BLOOMING OF GRAPES — *Continued.*

VINEYARD 8 — *Continued.*

	1892.	1893.	1894.	1895.	1896.	1897.	1898.
Mathilde	June 21	June 19	June 18	June 9	June 5	June 28 to July 4	June 16 to June 27
Maxatawney	June 17	June 17	June 18	June 3	———	June 26 to July 3	June 15 to June 27
Merrimack	June 18	June 17	June 18	June 4	June 6	June 24 to July 1	June 13 to June 21
Metternich	June 23	June 19	June 20	June 6	June 8	June 28 to July 5	June 23 to July 1
Mills	———	June 19	June 19	———	———	June 26 to July 4	June 20 to June 28
Missouri Riesling	June 20	June 15	June 20	June 3	June 5	June 24 to July 3	June 13 to June 21
Montefiore	June 20	June 17	June 18	June 6	June 1	June 23 to June 30	June 14 to June 30
Nectar	June 22	June 19	June 20	June 5	June 7	June 26 to July 2	June 16 to June 27
Noah	June 17	June 15	June 15	June 3	June 3	June 22 to June 30	June 13 to June 21
Northern Muscadine	June 17	June 17	June 18	June 3	June 4	June 25 to June 30	June 13 to June 21
Olita	June 22	June 19	June 20	June 4	June 6	July 2 to July 4	June 16 to June 28
Oneida	———	———	———	———	———	June 26 to July 2	June 16 to June 25
Paradox	June 21	June 19	June 19	June 6	June 5	June 26 to July 2	June 16 to June 26
Paragon	June 20	June 19	June 18	June 7	June 6	June 26 to July 2	June 16 to June 25
Pearl	June 18	June 17	June 16	June 3	May 29	June 21 to June 30	June 12 to June 20
Perkins	June 18	June 17	June 17	June 3	June 4	June 24 to June 30	June 13 to June 20
Pocklington	———	———	———	June 7	June 2	June 23 to July 2	June 15 to June 20
Profitable	June 20	June 17	June 15	June 5	June 5	June 23 to June 30	June 13 to June 20
Red Bird	———	———	———	June 5	June 6	June 23 to July 2	June 15 to June 24
Red Bird	June 20	June 19	June 18	June 4	June 6	June 26 to July 1	June 16 to June 20
Red Eagle	June 21	June 19	June 18	June 6	June 6	June 26 to July 4	June 16 to June 25
Requa	———	———	June 20	June 6	June 6	June 26 to July 2	June 16 to June 25
Rockwood	———	———	———	June 6	June 4	June 23 to June 30	June 15 to June 25
Roenbeck	———	———	———	June 6	———	June 29 to July 4	June 12 to June 25
Rogers No. 5	June 21	June 19	June 19	June 6	———	June 28 to July 4	June 16 to June 23
Rogers No. 13	June 20	June 17	June 18	June 3	June 6	June 24 to July 3	June 15 to June 21
Rogers No. 24	June 20	June 17	June 18	June 5	June 5	June 24 to June 30	June 16 to June 25
Rogers No. 32	June 20	June 17	June 18	June 6	June 5	June 24 to June 30	June 16 to June 25
Rommel	June 20	June 19	June 20	June 6	———	June 24 to July 2	June 15 to June 27
Roscoe	June 22	———	June 18	June 6	June 6	June 30 to July 4	June 16 to June 27

Ross (Gov.)	—	—	—	June 10	June 13	June 30 to July 3	June 21 to June 29
Rustler	June 21	June 19	June 18	June 6	—	June 30 to July 2	June 20 to June 27
Rutland	June 21	June 19	June 20	June 10	June 6	June 26 to July 4	June 20
Shelby	—	—	—	—	—	June 26 to July 3	June 16 to June 20
Shull No. 2	—	—	—	June 7	—	June 26 to July 2	June 16 to June 25
Standard	June 20	June 19	June 19	June 3	June 6	June 24 to June 30	June 15 to June 21
Telegraph	June 22	June 17	June 18	June 5	June 5	June 24 to June 30	June 15 to June 21
Thompson No. 5	—	—	—	June 4	June 7	June 23 to June 30	June 16 to June 23
Thompson No. 7	—	—	—	—	June 6	June 24 to July 4	June 16 to June 23
Triumph	June 23	—	—	June 11	—	June 30 to July 4	June 20 to June 30
Ulster	June 18	June 15	June 17	June 2	May 26	June 23 to June 30	June 12 to ?
Victoria	—	—	—	June 6	June 5	June 25 to July 1	June 16 to June 25
Vitis æstivalis	June 27	—	June 28	June 14	June 13	—	June 28 to July 3
Vitis arsonica	—	June 20	June 18	June 4	June 6	June 26 to July 2	June 13 to June 21
Vitis berlandieri	June 15	—	July 6	—	—	—	July 6 to July 15
Vitis champini	June 17	June 14	June 13	June 3	May 29	—	June 13 to June 17
Vitis cinerea	—	—	July 12	—	—	—	July 8 to July 18
Vitis cordifolia	—	June 23	—	—	—	—	June 20 to June 28
Vitis doaniana	June 17	June 15	June 18	June 3	May 29	June 22 to June 30	June 11 to June 17
Vitis labrusca	—	June 17	June 19	June 4	May 26	June 23 to July 2	June 15 to June 24
Vitis lincecumii var. *glauca*	—	—	—	—	June 13	—	? to July 2
Vitis rupestris	June 15	June 12	June 16	June 1	May 26	June 26	June 11 to June 17
Vitis solonis	June 17	June 10	June 11	May 30	May 21	June 15 to June 21	June 8 to June 15
Vitis solonis, var. *novo mexicana*	June 15	June 12	June 15	June 1	May 23	June 16 to June 26	June 11 to ?
Vitis vulpina	June 11	June 10	June 8	—	June 21	June 21 to June 24	June 7 to June 15
Wheaton	—	—	—	June 7	June 5	June 25 to July 2	June 15 to June 26
White Jewel	June 18	June 15	June 17	June 3	May 27	June 20 to June 30	June 12 to June 20
Winchell	June 21	June 19	June 19	June 6	June 5	June 26 to July 4	June 16 to June 26
Witt	—	—	—	June 10	June 5	June 26 to July 3	June 16 to June 26
Worden	—	—	—	June 7	June 4	June 23 to July 2	June 15 to June 21
Wyoming	—	—	—	June 6	June 2	June 24 to June 30	June 15 to June 23

VINEYARD 9.

	1892.	1893.	1894.	1895.	1896.	1897.
Blanco	———	June 19	June 18	June 10	———	June 28 to July 2
Brilliant	June 22	June 19	June 19	June 10	———	June 28
Burrows No. 42c	———	———	———	June 10	———	June 30 to July 2
Denison	———	———	June 19	June 11	———	June 28 to July 2
Gold Dust	June 20	June 19	June 19	June 6	———	June 28 to July 1
Golden Grain	June 21	June 19	June 18	June 6	———	June 28 to July 3
Lindley	June 21	June 19	June 19	June 7	June 8	June 30 to July 2
Lindmar	June 20	June 19	June 19	June 6	———	June 30 to July 3
Opal	June 23	———	June 22	June 10	June 8	June 30 to July 3

VINEYARD 11.

	1897.	1898.
Black Eagle	June 26 to July 3	June 15 to June 21
Brighton	June 26 to July 1	June 15 to June 21
Brilliant	June 24 to July 3	June 15 to June 20
Canada	June 20 to July 1	June 11 to June 16
Clinton	June 14 to June 21	June 7 to June ?
Eaton	June 24 to July 1	June 13 to June 18
Elvira	June 19 to June 26	June 10 to June 15
Etta	June 20 to July 1	June 12 to June 17
Gærtner	June 24 to July 1	June 13 to June 18
Iona	June 24 to July 3	June 16 to June 25
Isabella Seedling	June 24 to July 1	June 12 to June 18
Marion	June 14 to June 20	June 7 to June ?
Mills	June 24 to July 3	June 16 to June 25
Nectar	June 28 to July 3	June 15 to June 21
Noah	———	June 12 to June 17
Olita	June 24 to July 1	June 15 to June 23
Paradox	June 24 to July 1	June 13 to June 19

HOW MAY SELF-STERILITY IN THE GRAPE BE ACCOUNTED FOR?

With nearly all of the varieties under experiment the discharge of pollen from the anthers has been observed. In these cases it cannot be held that self-sterility is due to an insufficient supply of pollen.

Some of the self-sterile varieties have long stamens. That long-stamened varieties become self-pollinated has already been shown. The short-stamened varieties are self-sterile or nearly so. Does self-pollination occur with them? It certainly does in some instances; for covered clusters of certain short-stamened grapes have occasionally produced a little fruit. If self-pollination occurs with some short-stamened varieties it is reasonable to assume that it occurs with all such varieties. It seems impossible that all the pollen of a covered cluster could be discharged and none of the pistils become pollinated even if the stamens are short.[1]

[1] Green found that covered clusters of Lindley and Brighton set no fruit, but they set fruit perfectly when clusters of Delaware blossoms were inserted in the bags with them at the blooming period. Both Lindley and Brighton have short stamens. Cross Fertilization of Grapes. Minn. Exp. Sta. Bul. 32:229. 1893.

Why do not the self-sterile varieties become fertilized after being self-pollinated? Three explanations suggest themselves: First, the stigma may not be receptive when the pollen is discharged and the pollen may perish before the tubes enter the stigma; or, second, either the pollen or the pistils may be imperfectly developed; or, third, the pollen may be incapable of fertilizing a pistil of its own variety, because of a lack of affinity between the two.

While assisting the writer in crossing grapes in 1898 Close found that while castrating a cluster of Mills some anthers burst and allowed the pollen to escape, although the blossoms had not yet opened. After castrating several blossoms in the cluster he removed the rest and covered the cluster with a paper bag to exclude pollen from other flowers. The bag was not opened till the fruit on the vine was well developed. It was then found that fourteen fruits had developed. These ripened perfectly although eight of them were seedless. Fig. 10 is reproduced from a photograph of these fruits. Here is an instance in which self-pollination was effected by hand, before the natural blossoming period arrived, with the result that the pollen retained its vitality till the pistils became receptive and then performed its function successfully.[1] Millardet has found that stigmas of blossoms castrated just before blooming may retain their vitality without pollination for eight or nine days and that grape pollen may retain its vitality for two weeks, at least.

The evidence which has thus far been obtained does not support the idea that the failure of self-pollinated blossoms to set fruits can be attributed to the discharge of the pollen before the stigma becomes receptive.

In several instances pollen of self-sterile grapes has been applied to other varieties by hand and as a result perfect fruit has devel-

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[1] Millardet, A. L'Hybridation de la Vigne. Paris: 27, 31. 1891. Millardet quotes Castel as affirming that he had repeatedly caused the hybridization of the grape by dusting the stigmas with pollen of the preceding year. In view of the results of the test by Close, Castel's experiments should be repeated with precaution to prevent self-pollination when the blossoms are being castrated.

FIG. 10.—MILLS.

oped. With such varieties it cannot be maintained that self-sterility is due to imperfect development of the pollen. Most, if not all, of the grapes here listed as self-sterile have made a record of producing well-filled clusters of fruit in favorable seasons when so located that cross-pollination from some other variety could occur. This is good evidence that the pistils are, as a rule, well developed. Plate L shows the results of preventing cross-pollination with a practically self-sterile variety, the Eumelan. Not a fruit developed on all the covered clusters. At the close of the season only the stems remained, as shown in the illustration. Compare this with the clusters shown in Plate LIII which formed on self-sterile vines when the blossoms were exposed to cross-pollination. Figure 1 shows a cluster of Herbert and Figure 2 a cluster of Barry. Compare Plate LI, Figure 1, which shows the three best, and with one exception, the only self-fertilized clusters of Brighton which have been obtained, with Figure 2, which shows a cluster of Brighton, which was open to cross-pollination. In view of these facts the second explanation for the self-sterility which is found among grapes cannot be accepted.

By an examination of the parentage of the grapes which have been included in these investigations it is found that with the exception of the Eaton[1] all of the thirty-three self-sterile varieties, Class 4, are hybrids, and of the twenty varieties listed in Class 3 as perfectly self-fertile all but five are hybrids. It is well known that self-sterility is often found among plant hybrids.

The evidence that self-sterility in general is due neither to defective pollen nor to defective pistils may be summarized as follows:

1. Pollen is formed abundantly.

2. Pollen retains its vitality till long after the pistil should become receptive.

[1] Eaton is a seedling of Concord, but whether from a seed produced from self-fertilized flower or from a flower open to cross-pollination, the records do not state. It is commonly classed as a pure labrusca variety.

3. Pollen of self-sterile grapes may successfully fertilize other grapes.

4. Pistils of self-sterile grapes are usually well developed. They develop into fruit when cross-pollinated.

In view of the following considerations the most satisfactory explanation of self-sterility which can be presented appears to be that with self-sterile grapes there is a lack of affinity between the pollen and the pistils of the same variety.

1. Nearly all of the self-sterile list and of the list of varieties which give very imperfect self-fertilized clusters are known to be hybrids. Possibly all are hybrids.

2. Self-sterility is often found among plant hybrids.

The variability in the degree of self-fertility which has been observed with some varieties seems to be due to the production of more vigorous pollen or the development of a greater affinity between the pollen and pistils of the same variety under especially favorable circumstances. Thus Brighton is generally self-sterile. Under especially favorable conditions it has overcome self-sterility to so great an extent that a few self-fertilized fruits have developed. See Plate LI, Figure 1.

LENGTH OF STAMENS AS AN INDICATION OF SELF-FERTILITY.

An examination of the list of cultivated varieties included in these experiments, omitting Hopkins and Shelby, the stamens of which have not been observed, shows that only those varieties which have long stamens produce marketable clusters of fruit where the blossoms are bagged. This is certainly strong evidence that varieties having short stamens are not able of themselves to produce marketable clusters of fruit.

Twenty-six of the cultivated varieties which were tested, while not completely self-sterile, were nevertheless unable to produce marketable clusters where the blossoms were bagged. Eighteen of these have long stamens and eight have short stamens.

There were forty cultivated varieties which, so far as tested,

proved to be utterly self-sterile. The stamens of one of this class, Oneida, have not been observed. Of the remaining thirty-nine varieties, nine have long stamens and thirty have short stamens.

Eleven specimen vines, representing as many native species, were under observation. Three had long stamens and were self-fertile. Of the eight kinds which had short stamens three were self-sterile and the rest were self-fertile, one kind producing clusters which, though loose, were sufficiently well developed to be classed as marketable. So far as known all cultivated grapes which can develop marketable clusters when self-fertilized have long stamens; nevertheless the fact that a variety has long stamens cannot be accepted as a sure indication that it is self-fertile. On the other hand the fact that a cultivated variety has short stamens may be taken as pretty sure evidence that it is self-sterile, either completely or to such a degree that it cannot of itself produce marketable clusters of fruit.

VI. CHERRIES: LUTOVKA AND BRUSSELER BRAUN.*

S. A. Beach.

In 1895 this Station recommended a new cherry for trial as a late variety for home and market use and distributed buds under the name Lutovka to persons who applied for them.

The fruit did not answer to the descriptions of Lutovka published by Prof. Budd†, Ames, Iowa, by whom the variety was introduced into this country.

Specimens of the fruit were sent to Prof. Budd, who pronounced them true Lutovka. The stock had been obtained from John Wragg, a nurseryman at Waukee, Iowa. Later, trees of several varieties of European cherries which Prof. Budd had imported were obtained from him, and among them were the Lutovka and the Brusseler Braun. When these fruited it was discovered that the variety which had previously been obtained from Mr. Wragg under the name Lutovka was not like the Lutovka which Prof. Budd sent us, but was identical with the Brusseler Braun. It answered to the published descriptions of Brusseler Braun‡ and was found to be identical with that variety as grown at the Michigan Agricultural College and the Central Experimental Farm, Ottawa, Canada.

The object of this notice is to announce to those who have received cherry buds from this Station under the name Lutovka that

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* Reprint of a Station Circular.

† Iowa Agrl. Coll. Buls., 1885: 53; 1890: 7; 1893: 16.

‡ Iowa Agrl. Coll. Buls., 1890: 7; 1892: 16.
Mich. Agrl. Exp. Sta. Bul., 123 (1895): 24.
Can. Cent. Exptl. Farm Bul., 17 (1892): 6.

they should change the name to Brusseler Braun. The variety still promises to be a valuable acquisition because of its extremely late season, fine appearance and good quality.

The Station does not now offer buds of Brusseler Braun for distribution. Among those who secured buds of it from the Station in 1895 were many nurserymen from whom trees may now probably be obtained.

METEOROLOGICAL RECORD.

PRECIPITATION BY MONTHS SINCE 1882.

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
1882	......	......	......	......	......	3.69	2.42	2 37	1 25	0.62	1.22	0.55	......
1883	0.48	1.44	0.88	1.58	4.45	4.12	2.98	3.47	2 12	2.10	1.54	0.73	25.89
1884	1.83	2.01	2 54	0 83	2.49	2.01	2.33	1 44	3.17	1 67	1.01	0.97	22.30
1885	1.07	0.61	0.12	1.26	1.58	2.49	4.64	5.02	2 11	2.88	1.36	0.76	23.90
1886	1.13	0.95	1.13	4.13	1.92	2.92	4.41	2.86	2.31	1.79	3.48	1.24	27.87
1887	0.18	2.97	0.48	1.37	0 46	2 01	6 37	3.03	0.75	1.74	1.58	1.35	22.29
1888	0.78	1.04	1.43	3.09	2.79	3 88	0.99+	4.02	2.73	3.47	2.02	1.24+	27.48
1889	2.99+	0.25	0.66+	3.28	1.21	7.47	4.57	1.98	2.50	3 32	3.44	1.62	32.28
1890	2 16	1.45	2.16	2.20	5.49	5.26	1 07	4.34	5 81	4.54	2.40	......	36.88
1891	1.44	1.57	3 25	1.63	0 49	4 31	3 52	3.16	0 47	2.65	0.74	3 24	27.52
1892	0.57	0.88	0.55	0 67	4.04	3.95	1.89	4.77	1.12	1.34	2 67	0.72	23.17
1893	1 62	3.71	1.94	2 59	4 92	3.08	3.68	5 38	2.68	1.59	1.09	1.56	33.84
1894	2.21	2.71	1.36	2.43	7.03	1.77	1.50	1 22	4.64	3.59	0.43	0.47	29.36
1895	0.96	0 60	0.29	1.53	2 88	......	......	2.66	0.94	0.72	2.31	2.49	......
1896	1.19	2.28	0.84	0 41	2.31	3.71	4.12	3.33	4.27	2 26	2.18	0.71	27.61
1897	0.64	0.21	2.12	1.90	2.19	3.16	5.28	1.27	2 36	0.73	2.53	1.39	23.78
1898	1.74	0.33	1.54	2.03	1.90	2.39	1.32	3.60	1.86	3.83	2.03	0.33	22.90

WIND RECORD FOR 1898.

DATE.	January.				February.				March.				April.			
	Northerly, N. W. to N. E.	Easterly, N. E. to S. E.	Southerly, S. E. to S. W.	Westerly, S. W. to N. W.	Northerly, N. W. to N. E.	Easterly, N. E. to S. E.	Southerly, S. E. to S. W.	Westerly, S. W. to N. W.	Northerly, N. W. to N. E.	Easterly, N. E. to S. E.	Southerly, S. E. to S. W.	Westerly, S. W. to N. W.	Northerly, N. W. to N. E.	Easterly, N. E. to S. E.	Southerly, S. E. to S. W.	Westerly, S. W. to N. W.
	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.
1				24	8			16				18				21
2			7	15			7	14		12	1	4			2	15
3				24			2	17								24
4			18	2			24		2		4	9	2			22
5			1	17			20	4				24	11			13
6			21	3	4			5		1	1	11				24
7			3	18			6				20		6			14
8			8	16			15				24					16
9			9	14			8				24			7	4	1
10			11	6			3				24			3	12	
11		13		2			23			1	23		11		6	6
12		11	12	1			7	15			20		7			15
13	8			11		6	4	12			12	12	2	5		4
14				10			7	11				24		5		
15	2	7	7	5	2	10	5	2	2	10	4	5	18			5
16	16			2				24			24					24
17			1	15		5	2	14			3	21		1		15
18			4	4	1	2	13	2		10	5	3	13			4
19		3	13	1	9						12	12		16	7	
20			18	6		19				4		15			2	20
21				23		10				12	4					24
22		14	1		4			7		4	20			2	10	7
23		4	7	13				19	5		4	11	3		3	8
24				18	1		9	13		3	3	2	24			
25		12	2					15		8			11	9		
26			3	21				24			24		16	2	1	3
27				24				24			24			10	2	3
28	1	11		3				24		1	21			15		
29		1		15								17	5	3		5
30		7	3						2			14				24
31			17	4								24				
Total hours of movement	27	83	166	317	29	52	155	262	11	66	301	226	129	79	49	317
Per cent of time in each direction	4.6	14	28	53.5	5.8	10.4	31.1	52.6	1.8	10.9	49.8	37.4	22.5	13.8	8.5	55.2

WIND RECORD FOR 1898 — *Continued.*

DATE.	MAY.				JUNE.				JULY.				AUGUST.			
	Northerly, N. W. to N. E.	Easterly, N. E. to S. E.	Southerly, S. E. to S. W.	Westerly, S. W. to N. W.	Northerly, N. W. to N. E.	Easterly, N. E. to S. E.	Southerly, S. E. to S. W.	Westerly, S. W. to N. W.	Northerly, N. W. to N. E.	Easterly, N. E. to S. E.	Southerly, S. E. to S. W.	Westerly, S. W. to N. W.	Northerly, N. W. to N. E.	Easterly, N. E. to S. E.	Southerly, S. E. to S. W.	Westerly, S. W. to N. W.
	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.
1	1	10		7		5	1		7			13		4		
2		18	3		6		2	9			1	8		7		
3			10	10	8			10				24			18	2
4				22	8				2			22			12	7
5	15			5		5	1	2	14	1						24
6	8			7	1	1				7	5					24
7	11			2		7	10			8	12					4
8	19						9	15			7	14				1
9	2			3				24				23				4
10	2		13	3	3			6				24			8	
11	1	4	4	5			11	6	8			7			17	
12	2	3	4	8			6	14		9	2				7.5	1.5
13	5			9		3	8	8		9						17
14	1			9			5	18	2	1	2	8			3	
15		5	10		11			6	3			18			19	
16			8	5		9	6		11			2			9.5	8.
17				24		11	2			3	7	1				1 45
18			13	7			20	1			11	3	3			3
19			10	10	12		2	5			5	10	7			4
20	10			10				24			16	2				8
21		3	13					24	6			17				11
22			24		11			12	10	7			1			7
23			24		1	4		11		4	18		1		2	5
24	3		4	14				16		6	8	2	0.5		8	2.5
25	2			16			2	20	1		13	1				18
26		5		1	3			17		4	10		1			21
27	2	4				3	8			3	11	1	9			8
28		11	6				8	16		4	12	5			15	1
29			12	12	2			17				17			2	13
30				17			4	15	6	2		3				8
31				21												4
Total hours of movement	84	63	158	227	66	48	105	296	70	68	140	225	22.5	11	121	220.5
Per cent of time in each direction	15.8	11.8	29.7	42.7	12.8	9.3	20.4	57.5	13.9	13.5	27.9	44 7	6	2.9	32.3	58.8

WIND RECORD FOR 1898.—*Concluded.*

DATE.	September. Northerly, N. W. to N. E.	September. Easterly, N. E. to S. E.	September. Southerly, S. E. to S. W.	September. Westerly, S. W. to N. W.	October. Northerly, N. W. to N. E.	October. Easterly, N. E. to S. E.	October. Southerly, S. E. to S. W.	October. Westerly, S. W. to N. W.	November. Northerly, N. W. to N. E.	November. Easterly, N. E. to S. E.	November. Southerly, S. E. to S. W.	November. Westerly, S. W. to N. W.	December. Northerly, N. W. to N. E.	December. Easterly, N. E. to S. E.	December. Southerly, S. E. to S. W.	December. Westerly, S. W. to N. W.
	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.
1				17		4	3			2	12	4				19
2				12			15	2			10	12				9
3				16			20				4.5	7.5		1	6	
4				15							20			18		
5			6	8			2	12			23			2	1	17
6		2	5	6	10			5				24			8	14
7				19.5		2	14				3	15				22
8				19			5	19	1		10	11				22
9			11	3	4			14	7			2				20
10	6			16			15.5		1	6		2				24
11				24			18	4				24				24
12	4			5	1			23				8	17			1
13		6	7			3		5			17	1				21
14		4	8			1	11	3				17				16
15		4	14.5					23			2	16				4
16			7.5	6	2			16			6				12	
17	2			5		13	1.5	1			9				8	5
18			2.5	15.5		4	20				24		2			19
19	4			19			9		1			12	4	9	3	
20	1		2	19	1	12						21			18	
21		3	16			21	3				15.5				9	4
22			23				8	13			23	1			17	
23			11	8				22				24			3	16
24	8	1	3	7			20					24			3	14
25	0.5		8	6.5			24					18				6
26			8.5	7		1	10	13	1	10	2				9	
27				24				24	6			18				24
28				12		6		8				20			2	17
29			7			1	16.5				1	1			24	
30			15			2	12	9				20			12	11
31								24					15			7
Total hours of movement	25.5	20	155	289.5	18	70	227.5	240	17	18	182	302.5	38	30	135	336
Per cent of time in each direction	5.2	4.1	31.6	59.1	3.2	12.6	41	43.2	3.3	3.5	35	58.2	7.1	5.6	25	62.3

SUMMARY OF DIRECTION OF WIND FOR 1898.

	Northerly, N. W. to N. E.	Easterly, N. E. to S. E.	Southerly, S. E. to S. W.	Westerly, S. W. to N. W.	Total.
	Hours.	Hours.	Hours.	Hours.	Hours.
January	27	83	166	317	593
February	29	52	155	262	498
March	11	66	301	226	604
April	129	79	49	317	574
May	84	63	158	227	532
June	66	48	105	296	515
July	70	68	140	225	503
August	22.5	11	121	220.5	375
September	25.5	20	155	289.5	490
October	18	70	227.5	240	555.5
November	17	18	182	302.5	5 9.5
December	38	30	135	336	539
Total hours of movement	537	608	1,894.5	3,258.5	6,298
Per cent of time in each direction	8.6	9.5	30.1	51.8	....

READING OF MAXIMUM AND MINIMUM THERMOMETERS AT 7 A. M.

DATE.	January. Max.	January. Min.	February. Max.	February. Min.	March. Max.	March. Min.	April. Max.	April. Min.	May. Max.	May. Min.	June. Max.	June. Min.
1	34	13	31	12	31.5	20.5	.....	24	64.5	43	75	48
2	15	2.5	12	—2	34	17.5	.....	26	69	47.5	84	57.5
3	23.5	2.5	12	—2	35	18	.....	19.5	60	49	80	57.5
4	24	4	13.5	1.5	39	18.5	30	21	57.5	47	75.5	54
5	32	13	30.5	8	43	19.5	31.5	18	50.5	44	73	54
6	38	24	34	16.5	35	22	31.5	21.5	44	34	82	57
7	39	28	31.5	17	48	23	31	26	54	37.5	78.5	56.5
8	38	29	40.5	18	52	31	43	30	58.5	41.5	88	62
9	44.5	30	42	30	55	35	53	30	55	38.5	90	61
10	40.5	27	43	36	59.5	37	60	32.5	69	46	77	56
11	41.5	26	44	35	65	39	61.5	35	75.5	49.5	77	56
12	38.5	25	56.5	40	.....	45	64	38	68.5	50.5	85.5	65.5
13	57	35	46.5	31.5	.....	51.5	65	35	61	41.5	86	66
14	35.5	26	42	30	.....	35.5	69	37	62	44	79	64.5
15	33.5	28	35	28	.....	26	64.5	39	67	48.5	82	53
16	37	26	31	11.5	.....	27	57	42	57	45	61	40
17	27	15.5	11.5	4	.....	43	64.5	43	65	44	72	49
18	26.5	15	33	5	.....	29.5	69	39.5	59	46	80	58
19	38	18	39	27	.....	30	50.5	36	71	51	80	61
20	36	23	32.5	26.5	.....	40	44.5	36.5	78	56.5	68	53
21	41.5	34	38	30	.....	35	48.5	38	69.5	54	70.5	49
22	37	31	34.5	30	.....	32.5	51.5	35	78.5	58	63	52
23	38	31	37.5	26	.....	37	52	39	77	58	68.5	46.5
24	41.5	25	37.5	26	.....	25	54	45	71.5	58.5	77	54
25	27.5	25	37.5	20	.....	26	51.5	40.5	74	56	87	70
26	34	23	27.5	20	.....	29	51	36.5	61.5	54	86	70
27	26	21.5	30	20.5	.....	37.5	54	33	68	51	82.5	60
28	26.5	5	29	20	.....	46	61	34	69	51	75.5	63.5
29	17	3	.....	.....	.....	38	59	38	79	57.5	81	62
30	14	—4	.....	.....	.....	28	51	39	74.5	48	80.5	60
31	16.5	—4	....	.....	.....	28	.....	.....	60.5	49	.....	.....
Average	32.9	19.4	33.3	20.2	.....	31.3	*52.7	33.6	65.5	48.4	78.2	57.2

DATE.	July. Max.	July. Min.	August. Max.	August. Min.	September. Max.	September. Min.	October. Max.	October. Min.	November. Max.	November. Min.	December. Max.	December. Min.
1	93	66.5	83	66.5	90	65	85.5	58	43	32	36	27
2	86	64	76.5	62.5	92.5	70.5	80.5	59	50	35	33.5	27
3	96	72	86.5	66	93	72	79.5	62	49	33.5	39	28
4	96.5	71	86.5	67.5	94	72.5	83.5	66.5	59	34	43	28
5	78	56.5	74	61	93	61.5	77	66.5	63	39	36.5	31
6	71	45	80.5	63	85.5	62.5	77	44.5	59	43	33.5	28
7	85	55.5	83.5	65	86	62	54.5	38	48	35	34	22.5
8	87.5	64	86	67.5	67	49.5	67	43	43	33.5	32	19.5
9	93	60.5	78.5	64	73.5	53	64	44	60	41	27	17.5
10	77.5	50	77	61	78	52	66	35	44.5	35.5	27	15
11	71	42.5	75	60	78	43	68	38	44	31	25	20
12	68.5	40	83	61.5	67	46.5	75.5	50	35.5	26	29.5	20
13	78	49	77	58.5	66	44.5	55	36	47	28	21	8
14	80.5	55	76	58.5	74.5	51	50.5	38	47	30.5	13	3
15	92	63	78	59	72	54	51.5	41.5	44.5	33	21	9.5
16	85.5	61.5	81	61.5	78	57	44	40	44	31.5	25.5	17.5
17	82.5	54.5	87	68	83	62	50	32	48.5	34	36	20
18	88	64	79	62	80	60	54	32	50	35.5	38	27
19	90	72	70.5	58.5	81	57	51	40	49	42	37.5	14.5
20	92	66	69.5	52	70	50.5	57	39	45.5	40	37	15
21	88.5	67	78.5	56	60.5	40.5	64	40	40.5	31	42	36
22	88.5	66.5	85	63	66.5	44.5	54	50	53	32	46	36
23	91	69	87	66	71.5	56	61	42	53	26	45.5	36
24	88.5	69.5	90.5	70.5	79.5	51.5	54	38	35	25	39	31.5
25	95	69	89	67	64	50	63	39.5	28	23.5	37.5	25.5
26	90.5	68	83.5	57.5	76.5	52	63.5	43	28.5	20	29	18
27	89	68	83	52	71	49	61	34	26	18.5	34	19
28	89.5	69	68	47	66.5	48	38	31	28	16	38	7
29	94	68.5	74.5	54	74	50.5	45	32	34.5	23	27	8
30	93	65.5	86	63	79.5	54	53	34.5	35	30.5	50	27
31	83	63	85	62.5	.....	.....	55.5	39.5	.....	.....	54	17
Average	86.5	61.8	80.6	61.4	77.1	54.7	61.4	42.8	44.5	31.3	34.4	21.3

* Average for 27 days.

Readings of the Standard Air Thermometer.

Date.	January.			February.			March.			April			May.			June.		
	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.
1	13	14	7.5	12	10	5.5	24	29	27	26	35.5	33.5	49	65.5	58.5	60.5	80	77
2	2.5	16	17.5	-2	6.5	10	18	33	34	32	35.5	30	50.5	57	57	63	78	75
3	22	20	8.5	2	10.5	12.5	22.5	36	34	21	26.5	28	50	53.5	55	62	75	70
4	13	20.5	25	9	22	26.5	21	38.5	31.5	28	27	23	47.5	48	49	60	68	67
5	32	37	27.5	25	30	32.5	22.5	31	29	21.5	27	27	44	42.5	40.5	61	78	74
6	28	38.5	34	17	24.5	21	23	45	39.5	26	27	29	41	52.5	50	63	75	69
7	34	35.5	30	18	38.5	32.5	31	47	40	30.5	39	41	44	56	56	62	83	81.5
8	36	41	34	31.5	38	39	35.5	49	49	33	49	46.5	44	52	53	71	89.5	74
9	30	36.5	31.5	37	40	40.5	38	53	51	34	55.5	55	48	63	65	65.5	76	72
10	27	39	34	39	41	39.5	40	61.5	58	44	59	52	53	74	62	59	73	63
11	26	32.5	35.5	40	51	51	45	57.5	57	39	60	58	52	64	59	68	77.5	93
12	38.5	41	44	45	42.5	36	55.5	58	55	46.5	64	59.5	53	60	56	70.5	84	78.5
13	35	30	26.5	32	35	34	57	68	40.5	41	65.5	58	47	56	57.5	70	78	68
14	28.5	32	32	32.5	33	31	36	38	38	40	62.5	54	51	63	61	70	78	77
15	32	36	34	29	29	27	27	42	47	42.5	47	54	54	57	54.5	57	59	57
16	26	23	19.5	11.5	10	9.5	44.5	50.5	49	47	62	59	50	59	60.5	50	68	69
17	15.5	24	18	5	19	20	47	50	47	48	67.5	56	48.5	55	57	61	75.5	74
18	18	34	27	33	34	36	30	50	51.5	40	47	47.5	52	67	67	63	76	71
19	23	32.5	34.5	27	29	30	44.5	67	60	40	38	44	56.5	72	71.5	64	65.5	65
20	35	40	39.5	32.5	35.5	34	40.5	46	40	41.5	44.5	44	68	64.5	62	63	68.5	58
21	34	34	33.5	30	33.5	33	36	32.5	39	39	47	48	60	74	71.5	53.5	59	61
22	31	35.5	36	30.5	36.5	30.5	42	43	44	39	49	46	60	72.5	68.5	58	67.5	64
23	37	38	34.5	26.5	35.5	31	46.5	35	31	47	49	53	58.5	66	63	56	73	72.5
24	26	26	26.5	30	36.5	26	26	39	38.5	48.5	46.5	49	64	70	65	70.5	84	84
25	25	30	28.5	22	25	24	29	44	45.5	42	48	49	57	60	59	78	85.5	78
26	23	25	23	23	29	26	39.5	51	52	40	51	49.5	57	61.5	64.5	74.5	82	75
27	22.5	25	22.5	22	25	22.5	47	52	52	39	59	43.5	55	67	66.5	65	65	69.5
28	5	14	13.5	21	29.5	26	52	56	51.5	40	53.5	51	58	75	73	70	80.5	72
29	7.5	13.5	12	.....	.....	.....	38	38	39.5	39.5	44	48	66	69.5	64.5	65	75	74
30	3	9	2	.....	.....	.....	33	41.5	33	47	62	59	50.5	58	60	66.5	90	86
31	16.5	26	27	.....	.....	.....	29	38	35.5	.....	.....	.....	56	72.5	70	.....	.....	.....
Average	23.9	29	26.4	24.3	29.6	28.1	36.2	45.8	43.2	38.1	48.3	46.8	53.1	62.2	60.6	64	75.6	72

READINGS OF THE STANDARD AIR THERMOMETER — *Concluded.*

DATE.	July.			August.			September.			October.			November.			December.		
	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.
1	74	83	81	69	70.5	71.5	79.5	90.5	88	60	77	74	35	47	45	27	30.5	31
2	72	94.5	91	67	80	80	72	92	83.5	63	78	73	46	53	45	33.5	38	36
3	82.5	95	91	71	83	68.5	78	90	88	68	83	76	34	53	45	28	40	37
4	71.5	75.5	70	70	68	69.5	79	92	82.5	69	77	69	39	57.5	56	31.5	36	33.5
5	58.5	70	66	64	77	76	65.5	78	77.5	70	75	72	51	55.5	56	32.5	30.5	30
6	57	82	81	67	82	77	65	77	71	45	53	48	44	41	38	29	28	28
7	67	84.5	82.5	68	83	79.5	67	61	61	43	62.5	62	34	40	36	22.5	31	26.5
8	69.5	91	77.5	71	76	75	53	69	69	56	59.5	55	42.5	58	51	20	26.5	23
9	64	77	69	65	76.5	72	57	73.5	71	47	65	53	44	40.5	37	17.5	16	25
10	57	66	64	64	74.5	72	52.5	56	52.5	38	62	61	39.5	41	40	22	25	25
11	53	65	63	62.5	79	79	47	62.5	62	61	73.5	61	32	34	30	23	26.5	28
12	50.5	74	73.5	69	75	67	54	63.5	58.5	53	55	49.5	28	43.5	36	20	20	16
13	60	78	74.5	62	72	72.5	51.5	73	68	38	49	47	30.5	43	44	9	10	5
14	63	87	84	63	78.5	68	55	70	67.5	50.5	51	48	37	43	36	11	21	21
15	74.5	82	81	62	78.5	77	58	76	72	44	43	43	37	40	38	19	23.5	21
16	70	79	77	70	83	78	63	76	74.5	40.5	48	43.5	35	45.5	39	20	31.5	32
17	64	84.5	84	72.5	68	76	63	78	68.5	33	51	47	39.5	48.5	42	36	37	35
18	72	86	87	65	70	67	64	79	68	47	48.5	48.5	42	48	46.5	34	35.5	35
19	75	78	88	59	67	66	58	69	59.5	46	52.5	50	44	45.5	43.5	15	20	21.5
20	74	83	64	56.5	74.5	73.5	51.5	58.5	53.5	40	58	57	40	39	38	36	39	38
21	70	85.5	82	65	82	79	45.5	61	62	51	53	52	32	44.5	48	42	43.5	43
22	69.5	85	84	66	86.5	77	57	68	60	53.5	61	45	45	52	48	40	40	44
23	75	86.5	82.5	71	88	84.5	65	77.5	69	47	51	49	27	34	29	36	38	36
24	72	88.5	88	72	78	73	52	64	65	39.5	56	54	26	28	26	33	34	29
25	74.5	85.5	74	69	82	74	54.5	72	64	43.5	59.5	57	24	27	23.5	26	39	26.5
26	72.5	84	83	60	65	63.5	54.5	65	62.5	55	50.5	45	26	25	24	19	30	27
27	72	87	84.5	56.5	67	62	51.5	64.5	61	34	37	35.5	19	24	21	32	36	28
28	73	90	80.5	54	69.5	71	52	71	61	34	41	39	28	33	30	8	9	10
29	74	90	87	66	79	77	54	73	72	34.5	50	46	25.5	33	31	27	42	45
30	68	80.5	72.5	65.5	78.5	79	61.5	78	76	39.5	52	44	30.5	35	33.5	44	53	35
31	69	78	75	66	87.5	85	......	......	.....	41	41	39	......	......	.....	17.5	13	9
Average	68.3	82.4	78.8	65.4	76.7	73.9	59.4	72.6	68.3	47.9	57.2	53	35.2	41.7	38.5	26.2	30.5	28.4

SUMMARY OF MAXIMUM, MINIMUM AND STANDARD THERMOMETERS.

	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.
Maximum	32.9	33.3	......	*52.7	65.5	78.2	86.5	80.6	77.1	61.4	44.5	34.4
Minimum	19.4	20.2	31.3	33.6	48.4	57.2	61.8	61.4	54.7	42.8	31.3	21.8
Standard, 7 A. M...	23.9	24.3	36.2	38.1	53.1	64	68.3	65 4	59 4	47.9	35.2	26.2
12 M.....	29	29.6	45.8	48.3	62.2	75.6	82.4	76.7	72.6	57.2	41.7	30.5
6 P. M..	26.4	28.1	43.2	46.8	60.6	72	78.8	73.9	68.3	53	38.5	28 4

* Average for 27 days.

AVERAGE MONTHLY TEMPERATURE FOR FIVE YEARS

	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.
1894	29.7	20.6	38.9	44.1	55.5	67.8	74.2	66 8	64.9	52.7	36	31.5
1895................	21.8	16.9	26.9	44.4	59	......	......	71.2	61.7	45.4	39.6	31.4
1896................	22.4	24.1	24.4	49.3	62	65.9	71.4	70	60.2	56 5	42.9	27.1
1897................	23.2	26.1	33.8	45	55.4	62.3	73.6	67.6	62.3	52.6	39.7	29.2
1898................	26.2	26.8	......	43.2	57	67.7	74.2	71	65.9	52.1	37.9	27.9

READING OF SOIL THERMOMETERS.

DATE.	ONE INCH.			TWO INCHES.			THREE INCHES.			SIX INCHES.			NINE INCHES.			EIGHTEEN INCHES.		
	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7. a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.
May 1	46.5	57.5	58	47	56.5	58	46.5	53.5	56.5	48	50	54.5	48	48	50.5	46.5	46.5	46.5
2	50.5	53.5	54	51	53.5	54	50	52	53	50.5	51	52	49.5	49.5	50	47	47.5	47.5
3	50.5	51.5	52.5	51	51.5	52.5	50	50.5	51.5	50.5	50.5	51	49.5	49.5	49.5	47.5	47.5	47.5
4	49	50	50	50.5	50	50.5	49	49	49.5	49.5	49.5	49.5	49	48.5	48.5	47.5	47.5	47.5
5	48	48	47	48.5	48.5	48	47.5	48	47	48.5	48.5	48	48	48	47.5	47	47	47
6	42.5	53	54	42.5	52.5	54	43	50	53	45	47	52	46	46	49	46.5	46.5	46.5
7	45.5	53	53.5	45.5	53	53.5	45.5	51	52.5	47	49	51.5	47.5	47.5	49	47	47	47
8	45.5	54.5	54	45.5	54	54.5	45.5	52	53.5	47.5	49.5	52	48	48	49.5	47	47	47
9	45.5	58	60.5	45.5	57.5	61	45.5	54	58.5	47	49.5	55	47.5	47.5	51	47	47	47
10	49.5	60	57.5	50	60	58	49.5	56.5	56.5	50.5	52.5	55	50	50	51.5	48	48	48
11	51.5	60	57.5	52	60	58	51	56.5	57	52	53	56	51	51	52.5	48.5	48.5	49
12	52	52	57	53	52	57	52.5	51.5	55.5	52.5	52	54	51.5	51	51.5	49	49	49
13	49	57	59.5	49	57	59.5	49	54.5	58	50.5	52	55.5	50	50	52	49.5	49	49
14	50.5	62	61.5	50.5	61.5	62	50	58	60.5	51.5	54	58	51	51	54	49.5	49.5	49.5
15	53	54	54	53	54.5	54.5	52.5	53.5	53.5	53	53	53.5	52.5	52	52	50	49	49.5
16	50.5	55.5	58	50.5	55.5	58	50.5	53.5	56.5	51	52	54.5	51	51	52	49.5	49.5	49.5
17	48.5	57	57.5	48.5	57	58	48.5	54.5	56.5	50.5	52	55	51	50.5	52	49.5	49.5	49.5
18	49.5	62	60.5	49.5	61.5	61	49.5	58	59.5	50	53.5	57	51	51	53.5	50	50	50
19	55.5	62	63	56	62	63.5	55	59	61.5	54.5	56	59	53	53.5	55	50.5	50.5	51
20	60	63	61.5	60	63	61.5	58.5	61	60	57.5	58.5	59	55.5	55.5	56	51.5	52	52
21	56.5	64.5	66	56.5	64.5	66	56	61.5	64.5	56	58	61.5	55	55	57.5	52.5	52.5	52.5
22	57.5	66.5	64.5	58	66	65	57.5	63	64.5	58	59.5	61.5	57	57	58	53	53.5	53.5
23	58.5	61.5	62.5	59	61.5	63	58.5	59.5	62	58.5	59	60.5	57	57	57.5	54	54	54
24	59.5	65	64	59.5	65	64.5	58.5	62.5	63.5	58	59.5	63	56.5	57	60	54	54	55
25	59.5	61.5	61.5	59.5	61.5	62	59	60	61	59.5	59.5	60	58	58	58	55.5	55.5	55
26	58.5	61	63.5	58.5	61	64	57.5	59.5	62	58	58.5	60.5	57	57	58	55	55	55
27	57	67	66	57	67	66	57	63	64	57.5	59	60.5	57	57	58.5	55	55	55
28	56.5	70	69.5	57	70	70	56.5	65.5	68	57.5	60.5	65	57	57	60	55	55	55
29	62	66	66	62	66	66.5	61.5	64.5	65.5	61	62	64	59.5	59.5	60.5	56	56	56
30	57	60	61.5	57	61	62	57	59.5	61	59	59	60	58.5	58	58	56	56	56
31	53.5	70.5	68	53.5	70.5	68.5	53.5	65	67	55.5	59	64	56	56	59.5	55.5	55	55
Average	52.5	59.3	59.5	52.8	59.2	59.8	52.3	56.8	58.5	53.1	54.4	56.9	52.6	52.5	53.9	50.6	50.6	50.7
Average for depth given	.....	57.1	.....	.....	57.3	.....	.....	55.9	.....	.....	54.8	.....	.....	53	.....	.....	50.6	.....

READING OF SOIL THERMOMETERS — *Continued.*

DATE.	One Inch.			Two Inches.			Three Inches.			Six Inches.			Nine Inches.			Eighteen Inches.		
	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p.	7 a. m.	12 m.	6 p. m	7 a. m.	12 m.	6 p. m.
June 1	56.5	73	71	56.5	73	71.5	56.5	67.5	69.5	58	61	66	58	58	61	55.5	56	56
2	61	75	72	61	75	72.5	60.5	70	70.5	61	63.5	67.5	60	60	62.5	56.5	56.5	57
3	60.5	75.5	70.5	60.5	75.5	71	60.5	70	69.5	61.5	64	67	60.5	60.5	63	57.5	57.5	57.5
4	60.5	66	68.5	60.5	66	69	60	64	67	71	62	65	60.5	60	61	57.5	57.5	57.5
5	60	75.5	73	60	75.5	73	59.5	69.5	71	60.5	63.5	67.5	60	60	63	57.5	57.5	57.5
6	63	73	70	63	72.5	70	62	69	68	62.5	65	66.5	61	61	63	58	58	58
7	62.5	78	75	62.5	77.5	75.5	61.5	71.5	73	62	65	69.5	61	61	64	58	58.5	58.5
8	66	79	71.5	66	79	71.5	65	73	70	65	67	68.5	62	63	65	59	59.5	59.5
9	63.5	77	73	64	75.5	73	63.5	71.5	71	64.5	66.5	69	63	63	65	59.5	59.5	60
10	63	74	68	63	74.5	68.5	62.5	70.5	67.5	63	65.5	66.5	62.5	62.5	64	60	60	59.5
11	64	70	74	64	70	74.5	63	66	71.5	63	64	68	62	62	64	59.5	59.5	59.5
12	66.5	76.5	75	66.5	76.5	75	65	72	73.5	65	67	70.5	63	63.5	65	60	60	60
13	67.5	75	70	67.5	76	70	66.5	72	70	66	68	69	64.5	64.5	66	60.5	61	61
14	66.5	77.5	75.5	66.5	77	76	65.5	73.5	74.5	65.5	68	72	64	64.5	67.5	61	61	61.5
15	61.5	70.5	68	61.5	70.5	68	62	67.5	68	64.5	65.5	67.5	64	63.5	64	61.5	61.5	61
16	55.5	70.5	69.5	55.5	71	69.5	56	66.5	68	59.5	62.5	66	60.5	60.5	62.5	60.5	60	60
17	60	76.5	73.5	60	77.5	74	59.5	71	72	61	65	69.5	61	61	65	59.5	59.5	59.5
18	62.5	70.5	69	62.5	70.5	69.5	62.5	67	68	63.5	64.5	66.5	62.5	62.5	63.5	60	60	60
19	64	65.5	68	64	65.5	68.5	63	64	67.5	63.5	63.5	66	62	62	63	60	60.5	60.5
20	59	68.5	63	59	68	63	59	65.5	63	61	63.5	63.5	61	61	62	60	60	59.5
21	58	63	63.5	58	63	64	57.5	61	62.5	59	60	61.5	59	59	60	59	59	58.5
22	56.5	71	66.5	56.5	71	66.5	56.5	66	66	58	61.5	65	58.5	59	61.5	58	58	58
23	56	72	69.5	56	72	70	56	67.5	68.5	58.5	62	66.5	59	59	62.5	58.5	58.5	58.5
24	61	75.5	73.5	61	75.5	74	60	70	71.5	61	64.5	68.5	60.5	61	64	59	59	59
25	68.5	74.5	71.5	69	74.5	71.5	67	71	70	66	67.5	68	63.5	64	65	60	60	60.5
26	67	78	74	67	78	74	66	73	72.5	66	68	68.5	64	64.5	66.5	61	61	61
27	65	67	68	65	67	68	64.5	65	67	65	65	66	64	63.5	63.5	61.5	61.5	61
28	65.5	75	73	65.5	75	73	64.5	71.5	72.5	64.5	67	70	63	63.5	66	61	61	61
29	64.5	72	73.5	64.5	72	73.5	64	69.5	72	64.5	66	70	64	64	66	61.5	61.5	61.5
30	64.5	77.5	76.5	64.5	77.5	77	64	73	70	65	67.5	72	64	64	66	61.5	61.5	62
Average	62.3	73.1	70.9	62.4	73.1	71.2	61.8	69	69.5	62.6	64.8	67.6	61.7	61.8	63.8	59.4	59.5	59.5
Average for depth given	......	68.8	......	......	68.9	......	.....	66.8	......	......	65	......	......	62.4	......	......	59.5	......

READING OF SOIL THERMOMETERS — *Continued.*

DATE.	One Inch. 7 a. m.	One Inch. 12 m.	One Inch. 6 p. m.	Two Inches. 7 a. m.	Two Inches. 12 m.	Two Inches. 6 p. m.	Three Inches. 7 a. m.	Three Inches. 12 m.	Three Inches. 6 p. m.	Six Inches. 7 a. m.	Six Inches. 12 m.	Six Inches. 6 p. m.	Nine Inches. 7 a. m.	Nine Inches. 12 m.	Nine Inches. 6 p. m.	Eighteen Inches. 7 a. m.	Eighteen Inches. 12 m.	Eighteen Inches. 6 p. m.
July 1	68.5	80	77.5	68.5	80	78	68	75	76	68	70	73.5	66	66.5	68.5	62.5	63	63
2	68	81.5	80.5	68	81.5	80.5	67	76	77.5	67.5	70.5	74	66.5	67	69	63	63.5	63.5
3	72.5	86	82.5	72.5	85.5	82.5	71	80	80	70.5	73.5	76.5	68.5	69	71.5	64	64.5	64.5
4	72.5	80	75.5	72.5	79	75.5	71.5	76.5	74.5	71.5	73	73.5	69.5	69.5	70	65	65	65
5	66	80	75	66	79.5	75	65.5	74.5	74	67	69	72.5	66.5	66.5	68.5	64.5	64.5	64
6	61	79	77.5	61	80	77.5	61.5	73	75.5	64	67	72	64.5	64.5	68	64	64	63.5
7	66	81	79.5	66	81.5	79.5	65.5	75	77	65.5	69.5	74	66	66	69	63.5	64	64
8	67.5	83.5	78	67.5	84	78.5	67.5	77	76	68	71	73.5	67	67	69	64	64	64
9	65.5	78.5	73.5	65.5	[illegible]	74	66	73.5	73	67.5	69.5	71.5	67	66.5	68.5	64.5	64	64
10	61	73.5	71.5	61	74	71.5	62	69	70.5	64	66	69	64.5	64	66	64	63.5	63
11	58	74.5	72	58	75.5	72	58.5	68.5	70.5	61.5	64	69	62.5	62	65	62.5	62.5	62
12	57	75	73.5	57	76	73	58	69.5	71	61	64	68.5	62	61.5	65	62	61.5	61.5
13	63	77.5	77	63	77	76.5	62.5	71	74	63.5	66	70.5	63	63.5	66	62	62	62
14	63.5	81	80.5	63.5	80.5	80.5	63	73.5	77.5	64.5	68	73	64	64.5	68	62	62.5	62.5
15	69.5	80.5	80.5	68	80.5	80.5	68	74.5	77.5	68	70	74	66.5	66.5	69	63	63	63.5
16	69	82.5	81	68.5	83	81	67.5	76.5	78.5	68	70.5	75	67	67	70	64	64	64
17	65.5	81.5	79.5	65	81.5	79	65.5	75	76	67	69.5	73	67	66.5	69	64	64.5	64.5
18	70.5	77.5	80.5	70	77	80.5	69	73	77.5	69	70	74	67.5	67.5	69.5	64.5	64.5	64.5
19	72	76.5	81.5	72	76	81	70.5	73	77.5	70	71	74	68.5	68.5	70	65	65	65
20	70.5	81	80.5	70.5	80	80	69.5	75	77	70	72	74	68.5	68.5	70	65	65	65
21	70.5	85	83.5	70.5	85	83.5	70	78.5	71.5	70.5	73	77.5	69	69	72	65.5	65.5	65.5
22	71	87	85	71	86	84.5	70.5	79	81.5	71	73.5	78	70	70	72.5	66	66	66.5
23	73.5	84	79.5	73.5	83.5	79.5	72.5	78.5	77.5	72.5	74	76	70.5	70.5	72	66.5	67	66.5
24	72	86	86.5	72	85	86	71.5	79	83	71.5	73.5	79	70	70	73.5	67	67	67
25	73.5	85.5	75	73.5	84	75	72.5	79.5	73.5	73	75	73.5	71.5	71.5	71.5	67.5	67.5	67.5
26	71.5	81	80	71.5	81	80	70.5	77	78.5	70.5	73	76.5	69.5	70	72.5	67	67	67.5
27	71.5	82.5	81	71.5	82	81	71	78	79.5	71.5	74	78	71	71	74	68	68	68
28	72.5	84.5	83.5	72.5	84	83	72	79	81	72.5	75	79	71.5	71.5	74.5	68.5	68.5	68.5
29	71.5	83.5	81.5	72	82	81	71.5	78	79	72.5	74.5	77	71.5	71.5	73.5	69	69	69
30	70.5	81.5	78.5	70.5	80.5	78	70	76	76.5	71	72	76	71	70.5	72.5	68.5	69	68.5
31	70	79	76.5	70	79	76.5	70	75	75	70.5	72.5	74	70	70.5	71.5	67.5	68.5	68
Average	68.2	81	79	68.1	80.7	78.8	67.7	75.4	76.7	68.5	70.8	74.2	67.7	67.7	70	65	65.1	65
Average for depth given	.....	76.1	.....	.....	75.9	.....	.....	73.3	.....		71.2	.....	.....	68.5	.....	....	65	.....

READING OF SOIL THERMOMETERS — *Continued.*

DATE.	ONE INCH.			TWO INCHES.			THREE INCHES.			SIX INCHES.			NINE INCHES.			EIGHTEEN INCHES.		
	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.
August 1	70	72	74	70	72	74	69.5	70.5	73	70	70	72	69.5	69	70	68	67.5	67.5
2	68	78	78	68	77	78	68	74	76.5	68	71	75	68.5	68.5	71.5	67	67	67
3	69	77	73	69	76.5	73	69	74	74	70	71.5	74	69.5	69.5	71	67.5	67.5	67.5
4	69.5	70	71	69.5	70.5	71	69	69.5	70	70	69.5	70	69	68.5	69	67.5	67	67
5	65.5	75	74	66	74	74	66	72	73.5	67.5	69.5	72.5	67.5	67.5	69.5	67	66	66.5
6	66	73.5	73.5	66.5	73	73.5	66.5	71	73	68	69.5	72	68	68	69.5	67	67	66.5
7	67	76.5	75	67	85.5	75	67	73	74	68	70.5	73	68	68	70	67	67	67
8	70	73.5	73.5	70	73.5	74	69.5	72	72.5	70	70.5	72	69	69	69.5	67	67	67
9	67	74	72.5	67.5	73.5	72.5	67	71.5	71.5	68.5	70	71.5	68.5	68	69.5	67	67	67
10	66	72	70.5	66	72	71	66	72	70	67.5	68.5	70	67	67	68.5	67	67	66.5
11	64	74	75	64	73	75	64	71	74	65	68.5	72	66.5	66.5	69	66.5	66	66
12	67.5	71	68.5	68	71.5	69	67.5	70	68.5	68	69	69.5	67.5	67.5	68	66.5	66.5	66
13	62	71	71.5	62.5	69.5	72	63	68	71	65.5	67	70	66	66	67.5	66	66	65.5
14	64	74	69	64	73	69.5	64	70	69	65.5	68	69	65.5	66	67.5	65.5	65.5	65.5
15	63	72.5	72.5	63	71.5	73	65	69	71.5	65	67	70	67	67.5	67.5	65.5	65.5	65.5
16	67.5	73	72.5	68	72.5	72.5	67	70	71	67.5	68	70	67	66.5	67	65.5	65.5	65.5
17	68	72.5	71.5	68	71.5	72	67.5	70	70.5	68	69	69.5	67	67.5	68	66	66	66
18	66	70	69	66	70	69	66	68.5	69	67	68	69	67	67	67.5	66	66	66
19	64.5	67.5	69	64.5	67.5	69.5	64.5	66.5	69.5	66	66	69	66	65.5	67	65.5	65.5	65.5
20	59.5	69.5	71	60	69	71.5	60.5	66.5	70	63	65	69	64	64	66	65	65	64.5
21	61.5	72	72	63	71.5	72.5	62.5	68.5	71	64.5	66.5	70	65	65	67	65	65	65
22	65.5	75	74.5	66	74.5	74.5	65.5	71.5	73.5	66.5	69	71.5	66	67	68.5	65	65.5	65.5
23	69	75	77	69.5	75	77.5	69	72.5	75.5	69	70	73	68	68	70	66	66	65.5
24	71	78	72	71.5	77	72.5	70.5	75	71.5	71	72	71.5	69.5	70	70	67	67	67
25	69	74	71.5	69.5	74	72	69	72	71.5	69.5	70.5	71.5	69	69	70	67.5	67.5	67.5
26	63	67	67	63.5	66.5	67.5	64	66	67.5	66.5	67.5	68	67	67	67	67	67	66.5
27	60	67	67.5	60	67	68	61	65.5	67.5	63.5	65	68	65	64.5	66	66	65.5	65
28	57	65	67	57	65	67	58	63.5	66.5	61	62.5	66	63	62.5	64	65	64.5	64
29	62.5	69	71	63	68.5	71	62.5	66.5	69.5	63.5	65	68	63.5	64	65.5	64	64	64
30	65	74	74.5	65.5	73.5	74.5	65	70.5	73	66	67.5	70.5	65.5	65.5	68	64.5	65	65
31	65.5	75.5	76.5	66	75	76.5	65.5	72	75	67	69	73	67	67	69	65.5	67	66
Average	65.6	72.5	72.1	65.9	72.1	72.3	65.8	70.1	71.4	67	68.4	70.6	67	67	68.3	66.2	66.2	66
Average for depth given	.....	70.1	.....	.....	70.1	.....	.....	69.1	.....	.....	68.7	.....		67.4	.....	.....	66.1	.....

READING OF SOIL THERMOMETERS — *Continued.*

DATE.	One Inch.			Two Inches.			Three Inches.			Six Inches.			Nine Inches.			Eighteen Inches.		
	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.
September 1	72	79.5	79.5	72	79	80	71	76	78	70.5	72.5	75.5	69	70	72	67	67.5	67.5
2	71.5	80	79	72	79.5	79	71	76	77	71.5	73	75.5	70.5	71	72	68	68	68.5
3	74	81	81	74	80	81	73	77.5	79	72.5	74	77	71.5	71.5	73.5	69	69	69
4	73.5	81.5	79.5	74	80.5	79.5	73	77.5	78	73	74.5	76.5	72	72.5	73.5	70	70	70
5	69	74	75.5	69.5	73.5	75.5	69.5	72	74	71	71.5	73	71	71	71	70	70	69.5
6	68	74.5	72	68	74	72	68	72	71.5	69.5	70.5	71.5	69.5	69.5	70	69	69	69
7	68.5	66.5	64	69	67	64.5	68.5	67	65	69.5	68.5	67	69	68.5	67.5	68.5	68.5	68
8	57	64.5	65	57.5	64.5	65.5	59	63.5	65	62	63.5	65.5	64	63.5	64.5	67	66	65.5
9	58	67	67.5	58.5	67	67.5	59	65	67	61.5	63.5	67	63	63	65	65	65	64.5
10	60	61.5	60	60.5	62	60.5	61	61.5	61.5	63	62.5	63	63.5	63	63	64.5	64.5	64
11	52.5	62	62.5	53	62	62.5	54.5	60.5	62.5	58	59.5	63	60	60	61.5	63	63	62.5
12	56	65.5	64	56.5	65.5	64.5	57	63	64	59	61.5	64	60	60.5	62	62	62	62
13	54.5	69	66.5	54.5	69	67	55.5	65.5	65.5	58	62	64.5	59.5	60	62	62	61.5	61.5
14	57	64	65	57	65	65.5	57.5	62.5	64	59.5	61	63.5	60	60	62	61.5	62	61.5
15	58	67	69	58.5	67.5	69.5	58.5	64.5	68	60	62	66	60.5	61	63	61.5	62	62
16	62.5	68	71	63	69	71	62	66	70	63	64	68	62.5	63	65	62	62.5	62.5
17	64	71	71	64	72.5	71.5	63.5	69	70.5	64.5	66	69	64	64	66	63	63.5	63.5
18	64	69	69	64	69.5	69.5	63.5	67.5	69	65	66	68	64.5	64.5	65	64	64	64
19	59.5	65	63.5	60	65.5	63.5	60	64	64	64.5	63.5	65	63.5	63	64	64	64	63.5
20	55	61.5	60	55.5	62.5	60.5	56	61	61	59	60	62	60.5	60	61.5	63	62.5	62
21	51.5	59	61.5	51.5	60.5	62	53	58.5	61.5	56.5	58	61.5	58.5	58	60	61.5	61	60.5
22	55.5	61.5	61	56	61.5	61	56	60	60	58	59	60.5	58.5	58.5	59.5	60.5	60	60
23	64	67.5	67	63.5	68	67	62	65	66	61	62.5	65	60	60.5	62.5	60	60.5	60.5
24	59	58.5	59	59.5	59	59.5	60	59	59	62	60.5	60.5	62	61	60.5	61.5	61.5	61
25	55.5	64.5	65	56	66	65.5	56	63.5	64.5	58	60.5	64	59	59	61.5	60.5	60.5	60.5
36	57	60.5	61	57	61	62.5	58.5	60	63	59.5	60	63	60	59.5	60.5	60.5	60.5	60.5
27	55	62.5	62	55.5	64.5	63	56	62	62.5	58.5	60	63	59.5	59	61	60.5	60.5	60
28	54	66	63	54.5	67	64	55	64	63	57.5	60.5	64	59	59	61.5	60	60.5	60
29	55.5	64	66.5	56	65.5	67	56	62.5	66	58.5	60.5	64.5	59.5	59	61.5	60	60	60
30	60.5	68	70	61	69	70.5	60.5	65.5	69	61.5	63	67	61	61	63.5	60.5	61	61
Average	60.7	67.5	67.3	61	67.9	67.7	61.1	65.7	67	62.9	64.1	66.6	63.2	63.1	64.5	63.7	63.7	63.5
Average for depth given	.....	65.2	.....	.....	65.5	.....	.....	64.6	....	.....	64.5	...	...	63.6	.....	.....	63.6	.....

READING OF SOIL THERMOMETERS — *Concluded.*

DATE.	One Inch			Two Inches.			Three Inches.			Six Inches.			Nine Inches.			Eighteen Inches.		
	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.
October 1	61.5	68	69	62	69.5	69.5	61.5	66	68.5	63	64	67	62.5	62.5	64	61.5	62	62
2	62.5	69.5	69.5	63	70.5	70	62.5	66.5	68.5	63.5	64.5	67	63	63	64.5	62	62.5	62
3	65.5	72.5	72	65.5	72.5	72.5	65.5	69	71	65	66	69	64	64	66	62.5	63	63
4	67	71.5	70	67	71.5	70.5	66	69	69.5	66.5	67.5	68.5	65.5	65.5	66	63.5	63.5	64
5	68	72	71	68	72.5	71	67	70	70.5	67	68	69.5	66	66	67	64	64	64
6	55.5	59.5	59	56.5	61.5	59.5	58	61	60.5	62	61.5	63	63.5	62	62.5	64	64	63
7	51	57	60	51.5	58.5	61	52.5	57	60	56	57	60.5	58	58	59	62	61.5	61
8	58	60	60	58.5	61	60.5	58	59.5	61	59.5	59.5	61.5	59	59	60	60.5	60.5	60
9	51	58	57.5	51.5	59.5	58.5	52.5	57	58.5	56	56.5	59.5	57.5	57	58	59.5	59.5	59
10	48	55	58.5	49	56.5	59	50	54.5	58.5	54	54.5	58	55.5	55.5	57	58.5	58.5	58
11	57.5	63.5	62.5	57.5	64	63	57	60.5	62.5	57.5	59	62	57	57.5	58	58	58	58.5
12	54.5	57.5	54.5	55	58	55	55.5	56.5	55.5	57.5	57.5	57	58	57.5	57.5	59	59	58.5
13	47	53.5	52	48	53.5	53	49	52.5	52	52.5	53	54	55	54	54	58	57.5	57
14	51	52.5	52	51	52.5	52.5	51	52	52	53	53	53.5	54	54	53	56.5	56	56
15	48	48	47.5	48.5	48.5	48.5	49	48	48	51	50.5	50.5	52.5	52	52	55.5	55.5	55
16	45.5	48.5	48.5	47	49	49.5	46	48	49.5	48.5	49	50	50.5	50.5	51	54	54	53.5
17	41.5	47	49	45	48.5	49.5	43	46	49.5	46.5	46.5	50.5	48.5	48	48.5	53	53	52.5
18	45	46.5	47	48	48	49	46	46.5	47.5	48	48	49	49	49	49	52.5	52.5	52
19	47.5	50.5	52.5	49	51	52.5	47.5	49	52	49	49	51	49	49	50	52	52	52
20	46.5	50	53	47	51.5	54	47	49	53	49.5	49.5	53	50	50	51.5	52	52.5	52
21	49	50	51	50	50.5	51	49.5	49.5	50.5	51	51	51	51	51	51	52.5	52.5	52.5
22	52	55	49	52	55	50	51	53.5	50.5	51	52.5	50.5	51.5	51.5	51	52.5	53	53
23	46.5	49	48.5	47	49.5	49.5	47	48.5	49	49	49	50	50	49.5	50	52.5	52.5	52
24	43.5	48	50.5	46	48.5	51	45	47	50.5	47.5	47	49.5	49	48	48.5	52	51.5	51.5
25	46	50	52	44.5	51	53	45.5	48.5	51.5	48.5	48.5	51	49	49	50	51.5	51.5	51
26	51.5	53	50	51.5	53	50.5	51	52	50.5	51	52	51.5	50.5	51	51	51.5	52	52
27	41.5	41	41	46	46	45	43	42.5	42	46.5	45.5	45	48.5	47.5	47	51.5	51	50.5
28	40	44	45	45	45	47.5	41	43	45	43.5	44	46	44	45	46	49	49	49
29	39.5	43	45	38	44	48.5	40.5	42	45.5	43.5	43	46	45	44.5	45.5	48.5	48	48
30	41.5	48	46.5	42	48.5	47	43	46	46.5	44	45	46	45	45	46	48	48	48
31	43.5	44	41	44	44.5	43	43.5	44	43.5	45	45.5	45	46	45.5	45.5	48	48	48
Average	50.5	54.4	54.3	51.5	55.3	55.3	51.1	53.4	54.6	53.1	53.5	55	53.8	53.6	54.2	55.7	55.7	55.4
Average for depth given	.....	53.1	.....	.....	54	.....	.....	53	.....	.....	53.9	.....	.....	53.9	.....	.....	55.6	.....

SUMMARY OF SOIL THERMOMETERS.

	ONE INCH.				TWO INCHES.				THREE INCHES.				SIX INCHES.				NINE INCHES.				EIGHTEEN INCHES.			
	7 a. m.	12 m.	6 p. m	Average.	7 a. m.	12 m.	6 p. m.	Average.	7 a. m.	12 m.	6 p. m	Average.	7 a. m.	12 m.	6 p. m.	Average.	7 a. m.	12 m.	6 p. m.	Average.	7 a. m.	12 m.	6 p. m.	Average.
	Ave.	Ave.	Ave.		Ave.	Ave.	Ave.		Ave.	Ave.	Ave		Ave.	Ave.	Ave.		Ave.	Ave.	Ave.		Ave.	Ave.	Ave.	
May	52.5	59.3	59.5	57.1	52.8	59.2	59.8	57.3	52.3	56.8	58.5	55.9	53.1	54.4	56.9	54.8	52.6	52.5	53.9	53	50.6	50.6	50.7	50.6
June	62.3	73.1	70.9	68.8	62.4	73.1	71.2	68.9	61.8	69	69.5	66.8	62.6	64.8	67.6	65	61.7	61.8	63.8	62.4	59.4	59.5	59.5	59.5
July	68.2	81	79	76.1	68.1	80.7	78.8	75.9	67.7	75.4	76.7	73.3	68.5	70.8	74.2	71.2	67.7	67.7	70	68.5	65	65.1	65	65
August	65.6	72.5	72.1	70.1	65.9	72.1	72.3	70.1	65.8	70.1	71.4	69.1	67	68.4	70.6	68.7	67	67	68.3	67.4	66.2	66.2	66	66.1
September	60.7	67.5	67.3	65.2	61	67.9	67.7	65.5	61.1	65.7	67	64.6	62.9	64.1	66.6	64.5	63.2	63.1	64.5	63.6	63.7	63.7	63.5	63.6
October	50.5	54.4	54.3	53.1	51.5	55.3	55.3	54	51.1	53.4	54.6	53	53.1	53.5	55	53.9	53.8	53.6	54.2	53.9	55.7	55.7	55.4	55.6

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